AD-A101 195 CONSTRUCTION ENGINEERING RESEARCH LAB (ARMY) CHAMPAIGN IL F/G 13/2
SEISMIC INDEXING SYSTEM FOR ARMY INSTALLATIONS. VOLUME II. SEIS--ETC(U)
MAY 81 J D PRENDERGAST, W E FISHER
UNCLASSIFIED CERL-TR-M-290-VOL-2 NL

1 OF 1
AD
A101 195

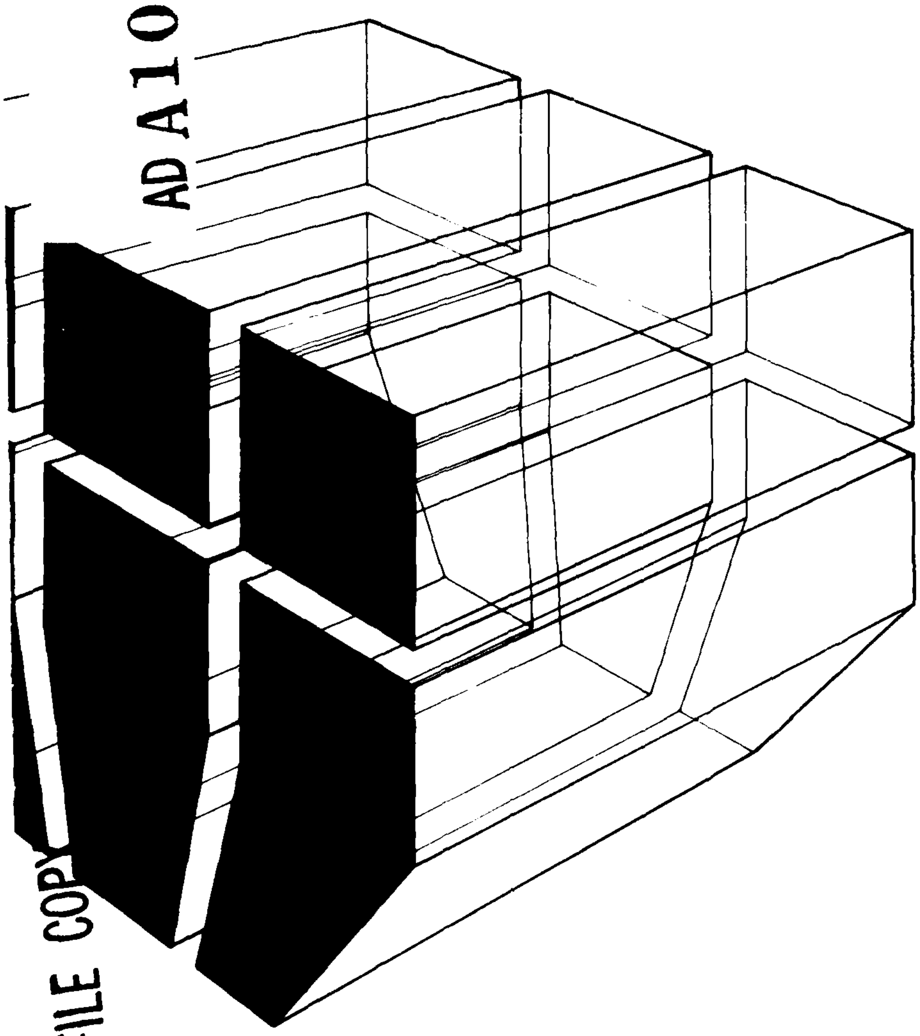
END
DATE
FILMED
8-81
DTIC

construction
engineering
research
laboratory

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

TECHNICAL REPORT M-290
May 1981

SEISMIC INDEXING SYSTEM FOR ARMY INSTALLATIONS
VOLUME II
SEISMIC HAZARD PRIORITY-RANKING PROCEDURE FOR ARMY BUILDINGS: BASIC CONCEPT



by
J. D. Prendergast
W.E. Fisher

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER CERL-TR-M-290-VOL-2	2. GOVT ACCESSION NO. AD-A101	3. RECIPIENT'S CATALOG NUMBER 795
4. TITLE (and Subtitle) SEISMIC INDEXING SYSTEM FOR ARMY INSTALLATIONS. VOLUME II. SEISMIC HAZARD PRIORITY-RANKING PROCEDURE FOR ARMY BUILDINGS: BASIC CONCEPT.		5. TYPE OF REPORT & PERIOD COVERED 9 FINAL Rept.,
		6. ~~PERFORMING ORG. REPORT NUMBER~~
7. AUTHOR(s) 10 J. D. Prendergast W. E. Fisher		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U. S. ARMY CONSTRUCTION ENGINEERING RESEARCH LABORATORY P. O. BOX 4005, Champaign, IL 61820		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 16 4A762719AT41-B-017 17
11. CONTROLLING OFFICE NAME AND ADDRESS 11		12. REPORT DATE May 1981
		13. NUMBER OF PAGES 62 12 67
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service
Springfield, VA 22151

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Earthquake engineering
military facilities
buildings

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Army is developing a capability to economically identify and evaluate the seismic capacity and strengthening strategies for essential and high potential loss facilities at Army installations, i.e., Mission Affordable Seismic Strengthening (MASS). One of the technological needs to achieve MASS is the development of a facility seismic hazard indexing procedure to identify existing facilities that are potentially seismically hazardous based on the information in the real property inventory for Army installations.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED 405279

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

BLOCK 20 CONTINUED

The basic concept of a seismic hazard priority-ranking procedure for Army buildings described in this volume is an integral part of the facility seismic hazard indexing procedure. The basic concept provides the framework for a preliminary, subjective seismic safety evaluation of existing Army buildings based on an analysis of the information contained in the inventory of Army military real property and the anticipated seismic exposure hazard. Further development of the basic concept is required to refine the basic indices, to establish weighting factors, and to automate the concept.

Volume I describes a procedure for screening the real property inventory of Army installations in order to eliminate minor facilities from the larger inventory and to provide a more manageable inventory for subsequent priority ranking.

FOREWORD

This project was conducted for the Directorate of Military Programs, Office of the Chief of Engineers (OCE), under RDT&E Program 6.27.12A; Project 4A762719AT41, "Design and Construction of Fixed Military Facilities"; Task B, "Advanced Technology for Military Construction"; Work Unit 017, "Mission Affordable Seismic Strengthening." The applicable QCR is 3.07.005. The OCE Technical Monitor was Mr. G. M. Matsumura, DAEN-MPE-B.

The work was performed by the Engineering and Materials Division (EM) of the U.S. Army Construction Engineering Research Laboratory (CERL).

Dr. R. Quattrone is Chief of EM. COL Louis J. Circeo is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.

CONTENTS

TABLES

FIGURES

SEISMIC INDEXING SYSTEM FOR ARMY INSTALLATIONS
VOLUME II: SEISMIC HAZARD PRIORITY-RANKING
PROCEDURE FOR ARMY BUILDINGS: BASIC CONCEPT

1 INTRODUCTION

Background

The Army currently operates and maintains 164 installations and major activities in the United States.[1] More than 127,000 buildings are located at these installations and major activities, and their original acquisition cost, excluding any adjustments for appreciation and depreciation, exceeds $11.5 billion.[2] Table 1 indicates the distribution of these installations and major activities by the seismic zones specified in the 1980 Draft Edition of TM 5-809-10, Seismic Design for Buildings (Figures 1 through 4).[3] Tables 2 and 3 indicate the distributions of the buildings and acquisition costs by seismic zones. Current DOD criteria require that studies be undertaken in areas of high earthquake activity (1) to evaluate the earthquake resistance of existing military facilities such as hospitals, fire stations, emergency operation centers, garages for emergency vehicles, and other operationally critical facilities, and (2) to develop a phased and orderly plan for completing the necessary seismic strengthening of these facilities.[4]

The huge inventory of existing buildings and the astronomical cost of retrofitting whole classes of hazardous buildings makes the hazard abatement problem a complicated, costly issue. The Army must develop a realistic and cost-effective capability to address this problem, i.e., Mission Affordable Seismic Strengthening (MASS). The generalized process for seismic strengthening of Army facilities and the technological needs to achieve MASS are summarized in Figure 5. MASS will provide a facility seismic indexing/priority ranking system to economically identify and evaluate the seismic capacity and strengthening strategies for essential and high potential loss facilities at Army installations. MASS includes processes to identify existing facilities that are potentially hazardous, to index the order for conducting seismic safety evaluations of potentially hazardous facilities, to evaluate the seismic capacity and upgrade requirements, to identify affordable strengthening designs and to prioritize the required strengthening in accordance with budgetary constraints and command goals.

---

1 United States Army Installations and Major Activities, DA PAM 210-1, (Department of the Army, February 1980).
2 Inventory of Army Military Real Property (Department of the Army, 30 September 1979).
3 Seismic Design for Buildings, TM 5-809-10, Draft Edition (Department of the Army, 1980).
4 Construction Criteria Manual, DOD 4270.1-M (Department of Defense, June 1978.)

Table 1

Distribution of Installations and Major Activities in the United States by 1980 TM 5-809-10 Seismic Zones

(From Inventory of Army Military Real Property [Department of the Army, 30 September 1979], and United States Army Installations and Major Activities [Department of the Army, February 1980].)

Installation/Activity	Seismic Zone 0	1	2	3	4	Total	Percentage
Barrack, Camp, Fort, Presidio, Reservation, or Station	4	29	23	3	10	69	42.1
Depot or Terminal	2	11	5	7	2	27	16.5
Arsenal or Plant	2	14	17	1	1	35	21.3
Medical Center	1	2	3	2	1	9	5.5
Special Mission	0	11	10	2	1	24	14.6
Total	9	67	58	15	15	164	100.0
Percentage	5.5	40.9	35.4	9.1	9.1	100.0	

Table 2

Total Acquisition Cost ($M) for Installations and Major Activities in the United States by 1980 TM 5-809-10 Seismic Zones

(From Inventory of Army Military Real Property [Department of the Army, 30 September 1979] and United States Army Installations and Major Activities, [February 1980].)

Installation/Activity	Seismic Zone 0	1	2	3	4	Total	Percentage
Barrack, Camp, Fort, Presidio, Reservation, or Station	709.7	2830.2	2869.1	537.3	559.3	7505.6	64.4
Depot or Terminal	5.9	406.8	223.1	269.3	38.8	943.9	8.1
Arsenal or Plant	3.8	1034.7	1000.2	16.8	79.8	2135.3	18.3
Medical Center	7.4	213.0	88.98	5.3	15.4	329.9	2.8
Special Mission	0	299.4	383.9	16.7	47.0	747.0	6.4
Total	726.8	4784.1	4565.1	845.4	740.3	11661.7	100.0
Percentage	6.2	41.0	39.1	7.3	6.4	100.0	

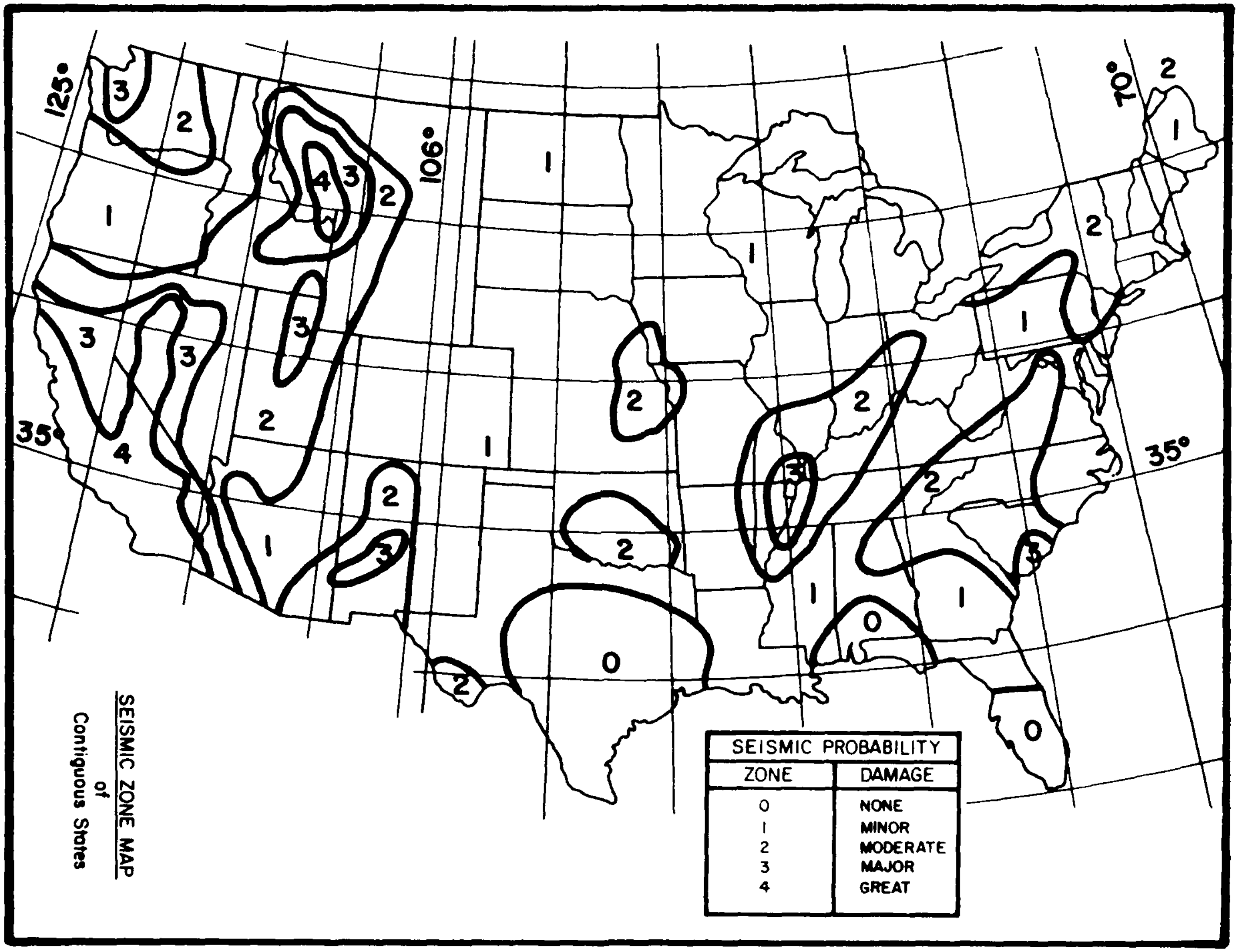


Figure 1. Seismic zone map for contiguous states. (From Seismic Design for Buildings, TM 5-809-10, Draft Edition [Department of the Army, 1980].)

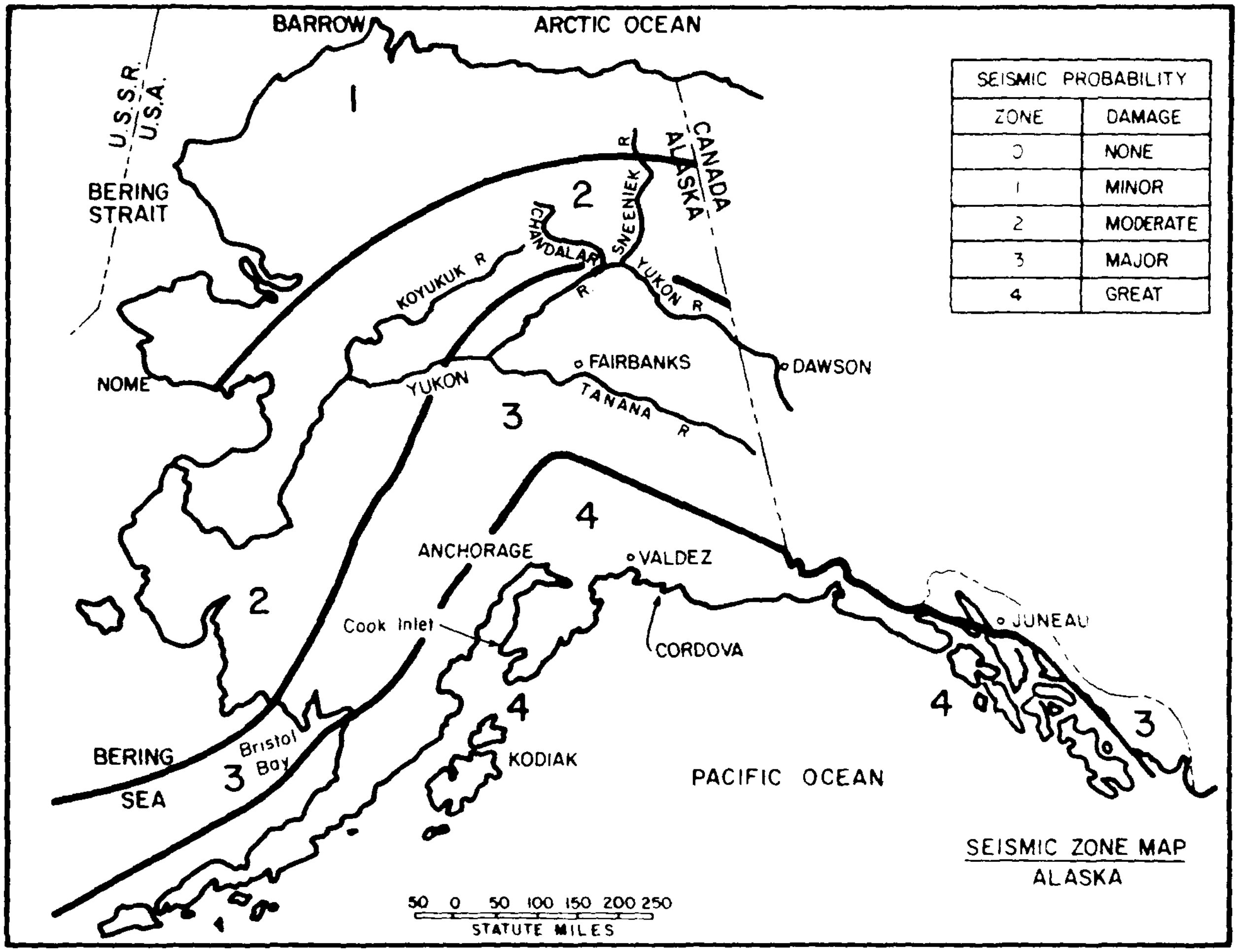


Figure 2. Seismic zone map for Alaska. (From Seismic Design for Buildings, TM 5-809-10, Draft Edition [Department of the Army, 1980].)

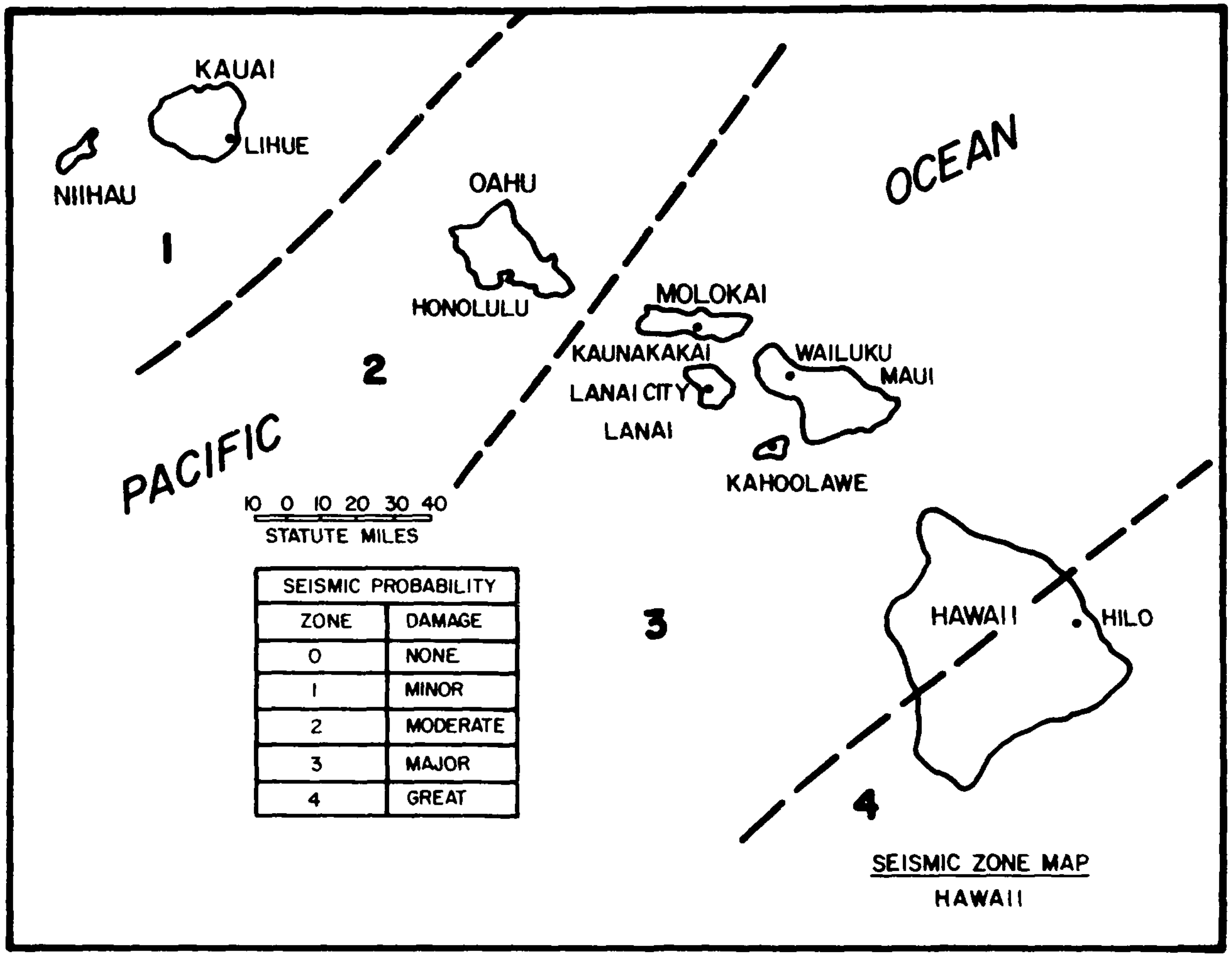


Figure 3. Seismic zone map for Hawaii. (From Seismic Design for Buildings, TM 5-809-10, Draft Edition [Department of the Army, 1980].)

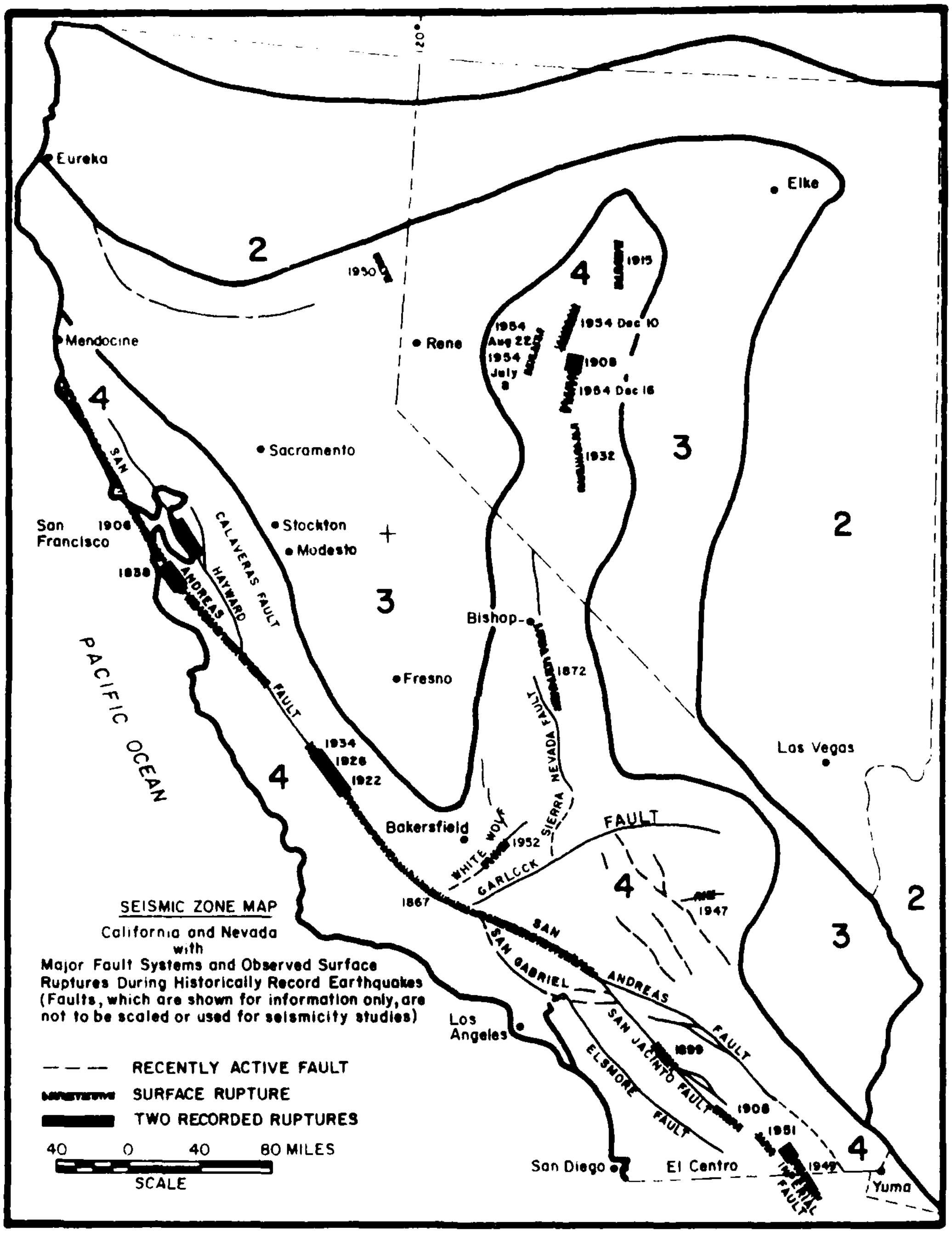


Figure 4. Seismic zone map for California and Nevada. (From Seismic Design for Buildings, TM 5-809-10, Draft Edition [Department of the Army, 1980].)

Table 3

Total Number of Buildings Within Installations and Major Activities in the United States by 1980 TM 5-809-10 Seismic Zones

(From <u>Inventory of Army Military Real Property</u> [Department of the Army, 30 September 1979], and <u>United States Army Installations and Major Activities</u> [Department of the Army, February 1980].)

Installation/Activity	Seismic Zone 0	1	2	3	4	Total	Percentage
Barrack, Camp, Fort, Presidio, Reservation, or Station	8499	32,612	30,126	4,464	6,488	83,189	65.5
Depot or Terminal	214	8,834	4,204	3,211	106	16,569	13.0
Arsenal or Plant	23	9,441	8,873	131	2,891	21,359	16.8
Medical Center	1	358	100	1	1	461	0.4
Special Mission	0	1,457	3,263	209	518	5,447	4.3
Total	8,737	52,702	46,566	9,016	10,004	127,025	100.0
Percentage	6.9	41.5	36.6	7.1	7.9	100.0	

GENERALIZED PROCESS VS. TECHNOLOGICAL NEEDS

PROCESS		NEEDS
IDENTIFY IMPORTANT FACILITIES	→	FACILITY INDEXING PROCEDURE
EVALUATE SEISMIC CAPACITY IDENTIFY STRENGTHENING REQUIREMENTS	} →	SEISMIC EVALUATION AND UPGRADE GUIDELINES
IDENTIFY AFFORDABLE DESIGNS ANALYZE TRADE-OFFS	} →	STRENGTHENING PRIORITIZATION PROCEDURE
PREPARE DD1391		

Figure 5. Overview of Mission Affordable Seismic Strengthening (MASS).

The seismic hazard priority-ranking procedure for Army buildings described in this report is an integral part of the on-going work to develop a facility seismic hazard indexing procedure.

Objective

The overall objective of this work is to develop a facility seismic indexing/priority-ranking system to economically identify and evaluate the seismic capacity and strengthening strategies for essential and high potential loss facilities at Army installations. The basic concept for a seismic hazard priority-ranking procedure for buildings is described in this volume. The objective of this work is to develop the framework for a preliminary subjective seismic safety evaluation of existing Army buildings based on analysis of the information contained in the inventory of Army military real property and the anticipated seismic exposure.

Scope

The seismic hazard priority-ranking procedure described in this report is applicable to building structures contained in the Army's real property inventory and is intended to provide meaningful rankings of buildings with a minimum of information. The procedure is still in an evolutionary state and has not been validated.

Mode of Technology Transfer

The information in this report will be used to prepare other material for inclusion in a new volume of TM 5-809-10, Seismic Design for Buildings.

2 INVENTORY OF ARMY MILITARY REAL PROPERTY

General

The key to a viable seismic hazard priority-ranking system for existing buildings is a comprehensive data base containing all the information and data required to make a rational seismic safety evaluation of the building. In view of this requirement, it is essential to review the existing inventory for Army facilities and identify the information cataloged in it.

The Army maintains a central inventory of military real property, which is a basic source of information on the status, cost, capacity, condition, use, maintenance, and management of real property both overall and by individual installations.[5] The central inventory is used as the basis for the annual publication Inventory of Army Military Real Property, for the Building Information Schedule, and for supplying information to other government offices and agencies. Installation reports are generally updated and revised at the end of each quarter in which reportable changes have occurred to reflect the real property as of that date. These reports, in the form of magnetic tape or punched cards, are submitted to HQDA (DAEN-REP-S).* These reports contain detailed information for each facility or item of real property that:

1. Describes its physical features
2. Reports its accountability
3. Furnishes location information on it
4. Describes its designed or permanently converted use.

Real Property Inventory (RPI)

Real property includes land and rights therein, ground improvements, utility systems, and buildings and structures, excluding plant equipment. Real property is classified according to the category codes and nomenclature system contained in AR 415-28.[6] Table 4 is a sample of this classification. A complete inventory of real property is maintained for each existing or newly acquired or activated installation located wholly within a state or country. When an installation is located in more than one state, each portion is treated as a separate installation and is given a separate installation number and submitted as a separate report.

---

[5] Inventory of Army Military Real Property, AR 405-45 (Department of the Army, 18 March 1977).

[6] Department of the Army Facility Classes and Construction Category, AR 415-28 (Department of the Army, August 1973).

* Systems Operation and Management Branch Programs Division, Directorate of Real Estate, Office of the Chief of Engineers.

Table 4

Sample of Facility Classes and Construction Categories

(From Department of the Army Facility Classes and Construction Categories, AR 415-28 [Department of the Army, August 1973].)

Facility classes, category groups, basic categories, and Army five-digit codes		Category short title	Unit of measure: Construction	Unit of measure: Form 2541 Area	Unit of measure: Form 2541 Other	General ledger account No.
100	OPERATIONAL AND TRAINING FACILITIES					
110	Airfield Pavements					
111	Airfield Pavement -- Runways	RUNWAYS	....	....	....	1702
	All runways, landing strips, helicopter landing pads, LTA landing mats.					
111 10	Fixed Wing Runway	FW Runway	SY	SY		
111 20	Rotary Wing Runway	RW Runway	SY	SY		
111 30	Helipads and Helicopter Parking Pads	Hlp & Hel Pk P	SY	SY		
111 40	Hoverpoint	Hoverpoint	SY	SY		
112	Airfield Pavements -- Taxiways	TAXIWAYS	....	....	....	1702
	All taxiways.					
112 10	Standard Taxiways	Std Taxiway	SY	SY		
112 20	High Speed Exit Taxiway	High Spd Ex Twy	SY	SY		
113	Airfield Pavements -- Aprons	APRONS	....	....	....	1702
	Maintenance, parking, access, operational and other aprons.					
113 10	Fixed Wing Aircraft Parking Apron	FW Ac Pk Apron	SY	SY		
113 20	Rotary Wing Aircraft Parking Apron	RW Ac Pk Apron	SY	SY		
113 30	Aircraft Maintenance Parking Apron	Ac Mt Pk Apron	SY	SY		
113 31	Field Maintenance Apron	Fld Mnt Apron	SY	SY		
113 32	Organization Maintenance Apron	Org Mnt Apron	SY	SY		
113 40	Hangar Access Apron	Hgr Access Apr	SY	SY		
113 50	Aircraft Holding Apron	Ac Holding Apr	SY	SY		
113 60	Aircraft Dispersed Hardstands	Ac Disprsd Hstd	SY	SY		
113 70	Aircraft Washing Apron	Ac Washing Apr	SY	SY		
113 80	Aircraft Loading Apron	Ac Loading Apr	SY	SY		
113 81	Personnel Loading Apron	Pers Ldg Apr	SY	SY		
113 82	Special Purpose Apron	Sp Purp Apr	SY	SY		
116	Airfield Pavements -- Other	OTHER AFLD PVMT	....	....	....	1702
	All other misc airfield pavements such as aircraft, washracks, compass swing bases, seaplane ramps.					
116 10	Aircraft Compass Swinging Base	Comp Swing Base	SY	SY		
116 90	Other	(Use Local Description)	SY	SY		
120	Liquid Fueling and Dispensing Facilities					
121	Aircraft Dispensing	FUEL DISP/ACFT	....	....	....	1715
	High and low speed normal fuel dispensing facilities.					
121 10	Aircraft Direct Fueling Facility	Ac Dir Fuel Fac	GM	(SF)	GM	

Table 4 (Cont'd)

Code	Facility classes, category groups, basic categories, and Army five-digit codes	Category short title	Unit of measure: Construction	Unit of measure: Form 2541 Area	Unit of measure: Form 2541 Other	General ledger account No.
121 20	Aircraft Truck Fueling Facility	Ac Trk Fuel Fac	GM	(SF)	GM	
121 90	Other	(Use Local Description)	GM	SF	GM	
122	Marine Dispensing	FUEL/DISP/MARIN	....	....	....	1715
	High and low speed normal fuel dispensing facilities.					
122 10	Marine Fueling Facility	Marine Fuel Fac	GM	(SF)	GM	
122 20	Small Craft Fuel Station	Sm Crft Fuel Sta	GM	SF	GM	
122 90	Other	(Use Local Description)	GM	SF	GM	
123	Land Vehicle Dispensing	FUEL/DISP/LAND	....	....	....	1715
	High and low speed normal fuel dispensing facilities.					
123 10	Gasoline Station With Building	Gas Sta w/Bldg	OL	SF	OL	
123 11	Gasoline Station Without Building	Gas Sta wo/Bldg	OL	....	OL	
123 20	Diesel Fuel Station With Building	Dsl Sta w/Bldg	OL	SF	OL	
123 21	Diesel Fuel Station Without Building	Dsl Sta wo/Bldg	OL	....	OL	
123 90	Other	(Use Local Description)	OL	(SF)	OL	
124	Operating Fuel Storage	OPER FUEL STOR	....	....	....	1715
	Immediate backup storage for dispensing facilities (exclude bulk, see 400 series at airfield and other land and marine stations.					
124 10	Aircraft Fuel Storage Aviation Gasoline	Ac Fuel Str Gas	GA	....	GA	
124 11	Aircraft Fuel Storage Jet Fuel	Ac Fuel Str Jet	GA	....	GA	
124 20	Tank Car Fuel Storage	Tk Car Fuel Str	GA	....	GA	
124 30	Drum Fuel Storage	Drum Fuel Str	GA	....	GA	
124 40	Marine Fuel Storage	Mar Fuel Str	GA	....	GA	
124 50	Vehicle Fuel Storage	Veh Fuel Str	GA	....	GA	
124 60	Propellant Storage	Propellant Str	GA	....	GA	
124 70	Fuel Oil Storage Tanks	Fuel Str Tank	GA	....	GA	
124 80	Diesel Oil Storage	Diesel Str	GA	....	GA	
124 90	Other	(Use Local Description)	GA	....	GA	
125	POL Pipeline	FUEL POL LINES	....	....	....	1721
	Pipeline, pumping stations, accessory equipment and appurtenances. (Exclude terminal and bulk storage tanks.)					
125 10	Pipeline Aboveground	Pipeline Ag	MI	....	MI	
125 20	Pipeline Underground	Pipeline Ug	MI	....	MI	
125 30	Pump Station Aboveground	Pump Sta Ag	(MI)	(SF)		
125 40	Pump Station Underground	Pump Sta Ug	(MI)	(SF)		
125 90	Other	(Use Local Description)	MI	(SF)	(MI)	
126	Liquid Fuel and Dispensing -- Other	FUEL DISP/OTR	....	....	....	1715
126 20	Propellant Fueling Facility	Propel Fuel Fac	OL		OL	
126 30	Tank Truck Loading Facility	Trk Load Fac	OL		OL	
126 35	Tank Truck Unloading Facility	Trk Unld Fac	OL		OL	
126 40	Tank Car Loading Facility	Car Load Fac	OL		OL	

Table 4 (Cont'd)

Code	Facility classes, category groups, basic categories, and Army five-digit codes	Category short title	Unit of measure: Construction	Form 2541: Area	Form 2541: Other	General ledger account No.
126 45	Tank Car Unloading Facility	Car Unld Fac	OL		OL	
126 50	Barge Loading Facility	Barge Load Fac	OL		OL	
126 55	Barge Unloading Facility	Barge Unld Fac	OL		OL	
126 60	Tanker Loading Facility	Tanker Load Fac	OL		OL	
126 65	Tanker Unloading Facility	Tanker Unld Fac	OL		OL	
126 90	Other	(Use Local Description)	OL	(SF)	OL	
130	Communications, Navigational Aids and Airfield Lighting					
131	Communications Buildings. Buildings for radio, radar, relay, telephone including globecom, base, net and similar operations. Exclude navigation and aviation aids.	COMMS BUILDINGS	....	....	....	1715
131 10	Cable House	Cable House	SF	SF		
131 20	Communications Center	Comm Center	SF	SF		
131 25	Military Affiliate Radio System Station	MARS Sta	SS	SF		
131 30	Communications Central Link Building	Comm Cen Bldg	SF	SF		
131 50	Helix House	Helix House	SF	SF		
131 60	Transmitter Building (Radio)	Xmtr Bldg Rdo	SF	SF		
131 65	Transmitter Building (TV)	Xmtr Bldg TV	SF	SF		
131 70	Receiver Building	Rcvr Building	SF	SF		
131 80	Telephone Exchange Building	Tel Exch Bldg	SF	SF		
131 81	Terminal Equipment Building	Term Eqp Bldg	SF	SF		
131 82	Commercial Facilities	Commercial Fac	SF	SF		
131 90	Other	(Use Local Description)	SF	SF		
132	Communications -- Other Than Buildings. Antenna system towers, communication control link facilities. Exclude navigation and aviation aids.	COMMS/OTHER	....	....	....	1715
132 10	Antenna Tower Supported	Ant Tower Supp	EA			
132 20	Antenna Vertical Radiator	Ant Vert Rad	EA			
132 30	Antenna Pole and Wire	Ant Pole & Wire	EA			
132 40	Switch Station Outdoor Antenna	Switch Sta Ant	EA			
132 50	Public Address System Outdoor	Pub Address Sys	EA			
132 90	Other	(Use Local Description)	EA			
133	Navigation and Traffic Aids Buildings. Buildings to house air traffic control.	NAVTR BLDGS -- AIR	....	....	....	1715
133 10	Flight Control Tower (High Density Traffic)	Flt Con Tow HD	SF	SF		
133 15	Flight Control Tower (Low Density Traffic)	Flt Con Tow LD	SF	SF		
133 20	Navigational Aids Building	Nav Aids Bldg	SF	SF		
133 40	Radar Building	Radar Building	SF	SF		
133 55	High Power Acquisition Radar Building	HIPAR Bldg	SF	SF		
133 56	Alternate Battery Acquisition Radar Building	ABAR Bldg	SF	SF		
133 60	Weather Station (Meteorological Building)	Weather Sta	SF	SF		
133 90	Other	(Use Local Description)	SF	SF		

Table 4 (Cont'd)

Facility classes, category groups, basic categories, and Army five-digit codes		Category short title	Unit of measure: Construction	Unit of measure: Form 2541 Area	Unit of measure: Form 2541 Other	General ledger account No.
134	Navigation and Traffic Aids Other Than Buildings. Radar approach control, visual aids, antenna systems, vaults, foundations, towers, beacons, and other structures which are non-ship related.	NAVTR AID/OTHER	....	....	....	1715
134 10	Low Frequency Nondirectional Radio Beacon	LF Radio Beacon	EA			
134 15	Radio Beacon Marker (75 MC)	Rdo Bea Mkr 75MC	EA			
134 20	Radio Beacon TVOR (Class "B" VOR)	TVOR	EA			
134 30	Ground Control Approach System	GCA	EA			
134 40	Instrument Landing System	ILS	EA			
134 50	Rotating Light Beacon	Rot Lt Beacon	EA			
134 60	Flashing Light Beacon	Fl Lt Beacon	EA			
134 70	Lighted Wind Direction Indicator	Lt Wind Dir Ind	EA			
134 80	Air Navigation Obstruction Lighting	Airnav Obst Ltg	EA			
134 90	Other	(Use Local Description)	EA			
135	Communication Lines. Marine cables, underground and overhead cables, open wire lines.	COMMS Lines	....	....	....	1721
135 10	Communication Lines	Comm Lines	MI	....	MI	
135 20	Marine Cables	Marine Cables	MI	....	MI	
135 90	Other	(Use Local Description)	MI	....	MI	
136	Airfield Pavement Lighting. Lighting both sides and approaches for all airfield pavements. Exclude airfield perimeter lighting, street lighting, and other general illumination. (See S12)	AFLD PVMT LTING	....	....	....	1715
136 10	Runway and Threshold Lighting -- Medium Intensity.	Runway Ltg-MI	LF	....	LF	

The RPI includes specific information regarding the installation such as its number, name, command code, using agency code, type, etc. In addition, the RPI contains a detailed inventory record for buildings and facilities, which includes the following information:

1. Category Code. The five-digit numerical code specified by AR 415-28 for identifying and classifying each item of real property.

2. Ownership Code. A numerical code from Table 5 representing the type of ownership or tenure for buildings and facilities.

3. Type of Construction Code. Permanent, semipermanent, and temporary construction are designated by the letters "P," "S," or "T," respectively.

4. Building/Facility Number. This is the five-character number assigned to a building, facility, or land for inventory purposes.

5. Building Code. Single- and multipurpose buildings and their uses are designated by a letter. The letter "B" indicates a single building used for only one purpose, as indicated by its assigned category code. The letter "P" indicates the principal category use of a multipurpose building. The letter "M" indicates secondary category uses.

6. Total Area. The amount of area for each item according to the applicable unit of measure specified in AR 415-28.

7. Outgrant Area. The amount of area outgranted by lease, easement, license, or permit to others.

Table 5

Type of Ownership Code

Code	Type of Ownership or Tenure
1.	Owned. Includes buildings and facilities constructed, purchased, or having a title owned by the U.S. Government, no matter how they were acquired.
2.	Leased (Inleased). Includes buildings and facilities held under lease agreements, including condemnation leaseholds.
3.	Other. Includes buildings and facilities acquired for use by license, permit (other than from the Air Force or Navy), temporary public land order, temporary executive land order, or furnished rent-free by a foreign government under treaty or other agreement.
4.	Permit--Military. Includes buildings and facilities other than land held under permit (not transfers) from the Air Force or Navy.

8. Planned Disposition Code. An appropriate code from Table 6 which indicates the planned disposition of vacant space.

9. Vacant Area. The amount of vacant area for each item.

10. Total Capacity (Other Measure). The quantity or number of units according to the applicable unit of measure specified in the "Other" column of Table 4. Table 7 lists the symbols for those units of measure.

11. Total Cost to U.S. Government. The cost expended by the U.S. Government to purchase or construct real property items.

12. Cost to U.S Government of Improvements on Leased or Rent-Free Land. The cost of owned units of real property constructed on leased or rent-free land.

13. Annual Rental Received. The amount of annual rental received for each item of outleased or outgranted real property.

14. Annual Rental Paid. The amount of annual rental paid for each item of real property under lease, license, or permit.

15. Appraisal or Estimated Value. The appraisal or estimated value of each item inleased, donated, or furnished by a foreign government.

16. Year Built or Acquired. The year of completion for buildings and facilities constructed by the Army or the year of initial acquisition or reacquisition for land and/or buildings and facilities not constructed by the Army.

17. Condition Code. The letters "U" and "N" designate whether the building or facility is usable or nonusable, respectively.

18. Number of Floors. The number of usable floors in a building, including full basement and attics.

19. Wall Material. A code (see Table 8) that represents the exterior surface material of the walls of a reported building.

Building Information Schedule (BIS)

BIS data is reported only for installations listed in Appendix A of AR 210-20 and for other Army installations that have mobilization potential expansion capability.[7] Table 9 lists installations currently in Appendix A of AR 210-20.

BIS data is not available if a building or facility is not in the RPI record. The BIS information includes the first four items in the RPI

[7] Master Planning for Army Installations, AR 210-20 (Department of the Army, 26 January 1976).

Table 6

Planned Disposition Code

Code	Planned Disposition
A	Mobilization requirement
B	To be disposed of
C	Planned future use
D	To be rehabilitated
E	Disposal under consideration
F	None

Table 7

Symbols for Units of Measure

(From Department of the Army Facility Classes and Construction Categories, AR 415-28 [Department of the Army, August 1973].)

Symbol	Unit of Measure
AC	Acres
BD	Hospital Beds, Normal Capacity
BL	Barrels, Capacity
BX	Boxes
CF	Cubic Feet
CY	Cubic Yards
EA	Each
FA	Family Unit
FB	Feet of Berthing
GA	Gallons, Capacity
GM	Gallons Per Minute, Capacity
KG	Thousand Gallons Per Day, Capacity
KV	Kilovolt-Amperes, Capacity (KVA)
KW	Kilowatt, Capacity
LF	Lineal Feet
MB	Million British Thermal Units Per Hour, Capacity
MI	Miles, Statute
MN	Persons, Designed Capacity
OL	Outlets, Number of
OU	Operating Units
SE	Seats
SF	Square Feet
SY	Square Yards
TN	Tons, Capacity
VE	Vehicles

Table 8

Wall Material Code

Code	Material	Abbreviation Used in Printout of Building Information Schedule
A	Wood	Wood
B	Brick (brick veneer)	Brick
C	Concrete	Concr
D	Concrete block or slag block	Block
E	Stone	Stone
F	Structural tile	Tile
G	Steel	Steel
H	Other	Other
J	Adobe	Adobe
K	Combination brick and wood asbestos shingle	Comb
L	Aluminum	Alum
M	Cement asbestos	C Asb
N	Cast iron	CI
P	Glass, plastic, transparent or translucent material	GL
Q	Roll, composition	R Comp

record -- the category code, ownership code, type of construction code, and buildings/facility number -- as well as information on the following items:

1. Utilities Available. The utilities available in the building or facility are indicated by an eight-digit/letter designation (see Table 10). The letter "X" designates that a utility or service is not available.

2. Current Use Code. The appropriate five-digit category code shown in Table 4 that best describes the facility's current use.

3. Recommended Use Code. The appropriate category code from AR 415-28 that best identifies the recommended long-range use if the estimated life of the facility is 20 years or more from the current date. If the estimated life is less than 20 years, the word "NONE" is used followed by a "D" or an "R," indicating demolition or replacement, respectively. The symbol "HIST" is used if the facility is to be maintained for historical purposes only.

4. Estimated Life. The estimated economic life of a building, and, when applicable, of a facility. A building's economic life is estimated using three factors: the foundation material, the principal type of building material, and the secondary type of building material, if it consists of more than one-third of the structure. The length of life is judged on the shortest life of the materials for the first three factors considered and then adjusted by special conditions. Figure 6 shows various materials and the ranges for estimating their economic lives.

Table 9

Army Installations for Which Permanent Construction Will Be Planned and Programmed

(From Master Planning for Army Installations, AR 210-20 [Department of the Army, 26 June 1976].)

List of installations for which complete master plans will be prepared.

US Army Training and Doctrine Command

Fort Belvoir, VA
Fort Benning, GA
Fort Bliss, TX (includes William Beaumont General Hospital)
Carlisle Barracks, PA
Fort Dix, NJ
Fort Eustis, VA
Fort Gordon, GA
Fort Hamilton, NY
Fort Benjamin Harrison, IN
Fort Jackson, SC
Fort Knox, KY
Fort Leavenworth, KS
Fort Lee, VA
Fort McClellan, AL
Fort Monroe, VA
Monterey, Presidio of, CA
Fort Rucker, AL
Fort Sill, OK
Fort Story, VA
Fort Leonard Wood, MO

US Army Forces Command

Fort Bragg, NC
Fort Campbell, KY
Fort Carson, CO
Fort Clayton, CZ
Fort Devens, MA
Fort Gulick, CZ
Fort Hamilton, NY
Fort Hood, TX
Fort Sam Houston, TX (includes Brooke AMC activity)
Fort Lewis, WA (includes Madigan General Hospital)
Fort McPherson, GA
Sharpe Army Depot, CA
Fort George G. Meade, MD
Fort Ord, CA
Fort Polk, LA
Fort Richardson, AK
Fort Riley, KS
Schofield Barracks, HI
Fort Shafter, HI
San Francisco, Presidio of, CA (includes Letterman General Hospital and Western Medical Research Laboratory)
Fort Sheridan, IL
Fort Stewart, GA (includes Hunter AAF)
Fort Wainwright, AK

US Army Materiel Development and Readiness Command

Aberdeen Proving Ground, MD (includes Edgewater Arsenal)
Anniston Army Depot, AL
Army Materials and Mechanics Research Center, MA
Deseret Test Center (Dugway Proving Ground), UT
Detroit Arsenal, MI
Frankford Arsenal, PA
Harry Diamond Laboratories, MD
Letterkenny Army Depot, PA
Lexington-Blue Grass Army Depot, KY
Fort Monmouth, NJ
Natick Development Center, MA
New Cumberland Army Depot, PA
Picatinny Arsenal, NJ
Pine Bluff Arsenal, AR
Pueblo Army Depot, CO
Red River Army Depot, TX
Redstone Arsenal, AL
Rock Island Arsenal, IL
Sacramento Army Depot, CA
Savanna Army Depot, IL
Seneca Army Depot, NY

Table 9 (Cont'd)

Sierra Army Depot, NA
Tobyhanna Army Depot, PA
Tooele Army Depot, UT
Watervliet Arsenal, NY
White Sands Missile Range, NM
Yuma Proving Grounds, AZ

US Army Security Agency

Arlington Hall Station, VA
Vint Hill Farm Stations, VA

US Army Communications Command

Fort Huachuca, AZ

US Army Military District of Washington

Fort McNair, DC
Fort Myer, VA
Cameron Station, VA

Military Traffic Management Command

Oakland Army Base, CA

Department of the Army Staff Agencies

West Point Military Reservation, NY

US Army Health Service Command

Fort Detrick, MD
Fitzsimmons General Hospital, CO
Walter Reed Medical Center, DC

List of US Army installations for which basic information documents will be prepared.

US Army Training and Doctrine Command

Fort Chaffee, AR
Fort A. P. Hill, VA
Fort Hancock, NY
Fort Hays, OH
Fort Hunter Liggett, CA
Fort Pickett, VA
Rocky Mountain Arsenal, CO
St. Louis Army Ammunition Plant, MO
Fort Totten, NY
Scranton Army Ammunition Plant, PA

Sunflower Army Ammunition Plant, KS
Twin Cities Army Ammunition Plant, KS
US Army St. Louis Area Support Center, MO
Volunteer Army Ammunition Plant, TN
Wingate Army Depot, MN

US Army Forces Command

Fort Amador, CZ
Fort Baker, CA
Fort Buchanan, PR
Camp Bullis, TX
Fort DeRussy, HI
Fort Douglas, UT
Fort Drum, NY
Fort Gillem, GA
Fort Greely, AK
Helemano Military Reservation, HI
Fort Indiantown Gap, PA
Fort Kobbe, CZ
Fort Lawton, WA
Fort MacArthur, CA
Fort McCoy, WI
Oakdale Support Center, PA
Quarry Heights, CZ
Fort Tilden, NY
Fort Totten, NY
Tripler Army Medical Center, HI
Fort Wadsworth, NY
Yakima Firing Center, WA

US Army Materiel Development and Readiness Command

Badger Army Ammunition Plant, WI
Burlington Army Ammunition Plant, NJ
Gateway Army Ammunition Plant, MO
Holston Army Ammunition Plant, TN
Indiana Army Ammunition Plant, IN
Iowa Army Ammunition Plant, IA
Jefferson Proving Ground, IN
Joliet Army Ammunition Plant, IL
Kansas Army Ammunition Plant, KS
Lake City Army Ammunition Plant, MO
Lima Army Modification Center, OH
Lone Star Army Ammunition Plant, TX
Longhorn Army Ammunition Plant, TX
Louisiana Army Ammunition Plant, LA
Michigan Army Missile Plant, MI
Milan Army Ammunition Plant, TN
Navajo Army Depot, AZ
Newport Army Ammunition Plant, IN
Radford Army Ammunition Plant, VA
Ravenna Army Ammunition Plant, OH
Riverbank Army Ammunition Plant, CA

US Army Communications Command

Fort Ritchie, MD

Military Traffic Management Command

Bayonne Military Ocean Terminal, NJ
Sunny Point Military Ocean Terminal, NC

Table 10

Utilities Available Code

Digit Position	Letter Designation	Meaning of Designation
1	W	Water is available
	X	Water is not available
2	S	Sewer (sanitary) is available
	X	Sewer (sanitary) is not available
3	E	Electricity is available
	X	Electricity is not available
4	T	Telephone is available
	X	Telephone is not available
5	D	Heated by space heaters
	H	Heated by individual heating plant
	M	Heated by plant that serves more than one building
	X	Not heated by any means Note: if either character in position 5 or 6 is "," then both should be "X."
6	C	Major heating fuel is coal
	O	Major heating fuel is oil
	I	Interruptible gas is supplemented with fuel oil for heating
	G	Major heating fuel is a firm supply of natural gas
	L	Major heating fuel is liquified petroleum gas
	Z	Major heating source is electricity
	X	No fuel or source of power required Note: if either character in position 5 or 6 is "X," then both should be "X."
7	Y	Cooled by evaporative cooling
	V	Mechanical ventilation only is available
	U	Cooled by individual direct expansion air-conditioning units
	R	Cooled by chilled water from a reciprocating central unit
	P	Cooled by chilled water from a centrifugal central unit
	A	Cooled by chilled water from an absorption central unit
	X	No means employed to cool the building or facility
		Cooled air is circulated by--
8	B	Low-velocity air from a single or multiple zone
	F	Fan coil unit
	J	High-velocity air utilizing double duct
	K	High-velocity air using induction
	Z	No distribution of cool air required

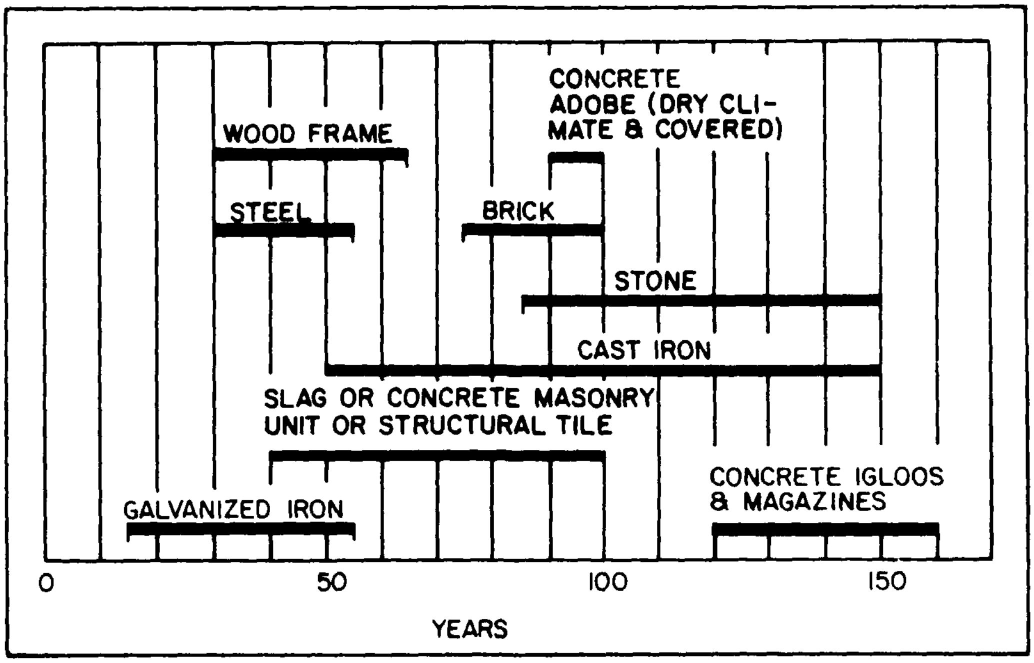


Figure 6. Estimated range of economic life for construction materials. (From Department of the Army Facility Classes and Construction Categories, AR 415-28 [Department of the Army, August 1973].)

5. Foundation Material. A two-code designation (see Table 11) which represents the foundation material. The first code indicates the foundation form, and the second indicates the pile or foundation material.

6. Structural Material. A two-code designation (see Table 12) which represents the structural material. The first code indicates the principal structural material, and the second indicates the secondary material. In smaller buildings, the surface material identified in Table 8 may be the only structural support. However, in larger buildings, the principal and secondary support may differ from the surface material.

7. Roof Material. A four-code designation (see Table 13) which represents the roof material. The first code indicates the type and material of roof support, the second indicates the roof deck material, the third indicates the roof surface material, and the fourth indicates the fire resistance rating of the entire structure.

8. MCA Number. The temporary or official DA line item number (MCA number) of the project that replaces a specific facility.

9. Current Use Description. A brief, descriptive phrase of the principal current use of facilities whose Current Use Code ends in 90.

Table 11

Foundation Material Code

1st Character -- Foundation Form

Code	Description	Abbreviation Used in Printout of Building Information Schedule
1	Pile -- all piles will be assumed to be capped with a continuous footing	PL
2	Pier	PR
3	Continuous footing of various shapes and forms	CON
X	No foundation	NF
	2nd Character -- Pile or Foundation Material	
M	Adobe	ADB
B	Clay or concrete brick	BK
C	Concrete	CN
L	Concrete, reinforced	CR
D	Slag, or concrete block	BLK
G	Steel	ST
E	Stone	STN
F	Tile, structural	TST
A	Wood	WD
X	No foundation material	NF

Note: If the first character is an "X," the second character must also be an "X."

Table 12

Structural Material Code

Code	Description	Abbreviation Used in Printout of Building Information Schedule
M	Adobe	ADB
N	Aluminum	AL
S	Cement asbestos	CA
I	Cast iron	CI
B	Clay or concrete brick	BK
C	Concrete	CN
L	Concrete, reinforced	CR
P	Glass, plastic, transparent, or translucent material	GL
D	Slag or concrete block	BLK
G	Steel	ST
E	Stone	STN
F	Tile, structural	TST
A	Wood	WD

Table 13

Roof Material Code

1st Character -- Type and Material of Roof Support

Code	Description	Abbreviation Used in Printout of Building Information Schedule
1	Flat truss -- concrete, reinforced	CRF
2	Flat truss -- steel	STF
3	Flat truss -- wood	WDF
4	Gable or arch truss -- concrete, reinforced	CRG
5	Gable or arch truss -- steel	STA
6	Gable or arch truss -- wood	WDG
7	Joist or beam -- concrete, reinforced	CRJ
8	Joist or beam -- concrete, pretressed	CPJ
9	Joist or beam -- steel	STJ
Y	Joist or beam -- wood	WDJ
Z	Slab -- concrete, reinforced	CRS
R	Rafters	RAF
X	Arch -- no support required	

2nd Character -- Material of Roof Deck

Code	Description	Abbreviation Used in Printout of Building Information Schedule
1	Cement asbestos	1
2	Asbestos protected metal	2
3	Asphalt protected metal	3
4	Gypsum or lightweight concrete	4
5	Masonry arch	5
6	Metal	6
7	Reinforced concrete	7
8	Wood (less than 2 in. thick)	8
9	Wood (2 or more in. thick)	9
0	Wood fiber cement	0
C	Concrete arch	C
S	Steel arch	S
G	Glass, plastic, transparent,or translucent material	G
M	No roof decking	M

Table 13 (Cont'd)

3rd Character -- Material of Roof Surface

Code	Description	Abbreviation Used in Printout of Building Information Schedule
N	Aluminum, copper, or lead	AL
P	Built-up roll roofing without gravel	RBU
B	Built-up roll roofing with gravel	RBG
X	Cement asbestos	CAS
M	No surface	NS
Q	Roll--building paper	PRB
R	Roll--composition	CPS
S	Shingles--composition	SC
T	Shingles--slate	SL
U	Shingles--wood	SWD
V	Steel, galvanized	STG
L	Tar or silicone	TS
W	Tile	TL
G	Glass, glass fiber, plastic, transparent, or translucent materials	GL

4th Character--Building Fire Resistive Rating and Degree of Sprinkler Protection

Code: Unsprinkled	Code: Pre-Action or Deluge	Code: Sprinklered Wet System	Code: Sprinklered Dry System	Description	Abbreviation: Unsprinkled	Abbreviation: Pre-Action or Deluge	Abbreviation: Sprinklered Wet System	Abbreviation: Sprinklered Dry System
1	5	W	D	Combustible	1	5	W	D
2	6	E	R	Unprotected noncombustible	2	6	E	R
3	7	T	Y	Protected/noncombustible (1 hr fire resistance)	3	7	T	Y
4	8	S	P	Fire resistive (2 hr or more fire resistance)	4	8	S	P

(Abbreviation = Abbreviation Used in Printout of Building Information Schedule)

3 BASIC CONSIDERATIONS

General

Two independent parameters must be characterized in order to assess the potential seismic hazard posed by a building because of a strong-motion earthquake. The first is the likelihood of occurrence of a strong-motion earthquake, and the second is the likelihood of damage and loss of life, assuming that the destructive earthquake occurs. Neither of these parameters alone is sufficient to assess potential seismic hazard. Therefore, it is essential to identify the key factors influencing these parameters and to develop a method of characterizing them.

Earthquake Hazards

The potential damage to a building from a moderate to great earthquake is influenced by such factors as the magnitude of the earthquake, duration of ground shaking, depth of the earthquake's focus, orientation of the building with respect to an active fault, distance from the epicenter, and the characteristics of the rock and earth through which the earthquake motions propagate to reach the building. The significance of some of these factors is not yet fully known or understood. Moreover, the relative importance of these factors may vary considerably from one location to another, and sometimes within a relatively short distance.

During a moderate to great earthquake, these factors and possibly others may combine to produce four potential hazards at a particular site:

1. Ground Shaking. The energy released during an earthquake causes the earth to vibrate within the vicinity of the earthquake's epicenter. As the earth vibrates, all ground surface elements, whether natural or manmade, will respond to that vibration in varying degrees. The violent and random nature of the ground motions induce inertia forces in manmade structures and cause the structures to v te in a complex manner.

2. Surface Faulting. Most great earthquakes will be accompanied by several feet of fault displacement, which may extend for many miles along the fault trace. Surface faulting produces scraps, grabens, fractures, and mole tracks or "pressure ridges." Ground displacements along the fault may be horizontal, vertical, or both.

3. Ground Failures. Moderate earthquakes generally induce ground failures in the form of landslides, settlement, and liquefaction. In great earthquakes, there are usually large movements of rock and earth over wide areas. Tectonic subsidence, uplift, tilting, and warping may also occur.

4. Tsunami and Seiches. A tsunami, or seismic seawave, is produced by abrupt movement of land masses on the ocean flow. Tsunamis are very high-velocity waves with long periods of oscillation. Their low wave height gives little evidence of their existence in the open sea. However, as the waves approach land, their velocity decreases and their height increases.

Inundation heights of 20 to 30 ft (6 to 9 m) have been observed during a tsunami. Seiches, or periodic oscillations (sloshing), of bodies of water such as ponds, lakes, bays, and landlocked seas also usually occur in moderate-to-great earthquakes. Seiches may raise and lower a water surface from a few inches to several feet and may occur many miles from the epicenter.

Of the four potential earthquake hazards, ground shaking is the predominant factor in terms of structural damage to buildings.

Indexing Earthquake Hazard

Except for ground shaking, little work has been done to develop a nationwide indexing system for earthquake hazards. In some areas, maps have been prepared to identify potential landslide areas or other areas of soil instability and these have been useful in land-use planning. However, it may be some time before it will be possible to develop a meaningful indexing system for earthquake hazards other than ground shaking.

A number of indexing systems have been developed for ground shaking. Using past earthquake history, it is possible to construct a map of the United States for the historically recorded Modified Mercalli Intensities (Figure 7). Using historical data of this type, it is possible to create a pseudo-seismic risk map like the ones shown in Figures 1, 2, 3, 4, and 8. The problem associated with these maps is that they are based on estimates of the maximum ground shaking experienced during the recorded historical period, with only minor consideration of how frequently such motions have occurred. Recently, the Applied Technology Council made a first attempt at incorporating seismic risk procedures into zoning maps for the United States. These seismic hazard maps were developed (1) to incorporate the attenuation of ground motions from the anticipated earthquake sources, and (2) to have the probability of exceeding the design ground shaking roughly the same in all parts of the country. However, the maps did not include detailed representation of the fault system or provisions for incorporating uncertainty. To represent the intensity of ground shaking, two parameters were adopted: effective peak acceleration (EPA) and effective peak velocity-related acceleration (EPV). Figures 9 and 10 show the EPA and EPV maps, respectively.

In Figure 9, the maximum value assigned to EPA at any point on the map is 0.4 g; however, this maximum is not intended to represent an absolute upper bound. There are locations inside the 0.4-g contour where higher values of EPA would be appropriate; however, contouring such small areas would have required special site-dependent studies.

The EPV map shown in Figure 10 was constructed by modifying the EPA map, but a different attenuation relationship was used in the eastern half of the country. In the western half, the distance required for the EPV from a large earthquake to be reduced to one-half its original value is about 80 miles. However, attenuation data of Modified Mercalli Intensity in the eastern United States has indicated that reduction of EPV to one-half its original value required 100 miles; thereafter, the distance required for the one-half reduction almost doubles. These modifications produced the map shown in Figure 10.

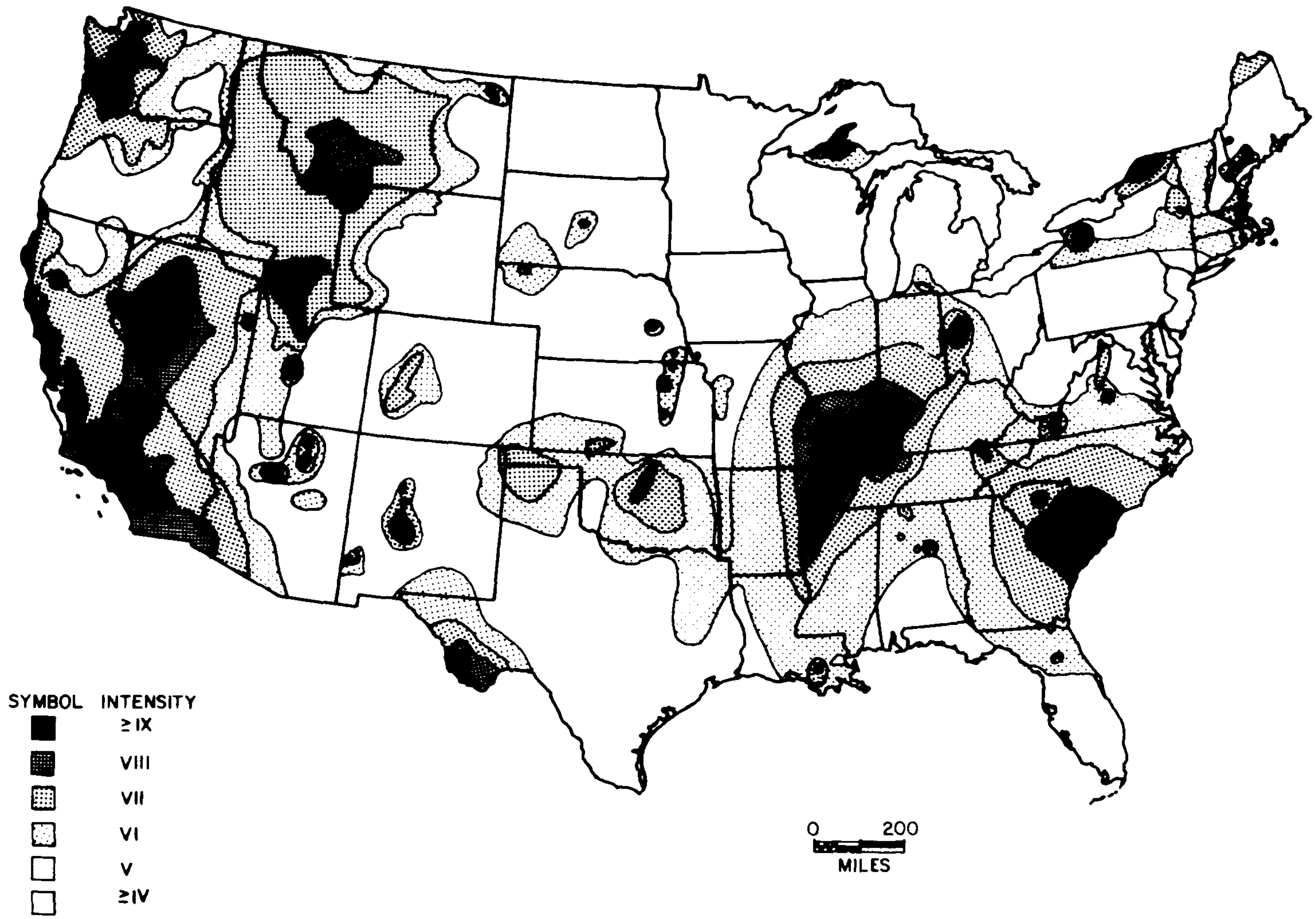


Figure 7. Maximum Modified Mercalli Intensities through 1965. (From Natural Hazards Evaluation of Existing Buildings, NBS BSS 61 [National Bureau of Standards, January 1975].)

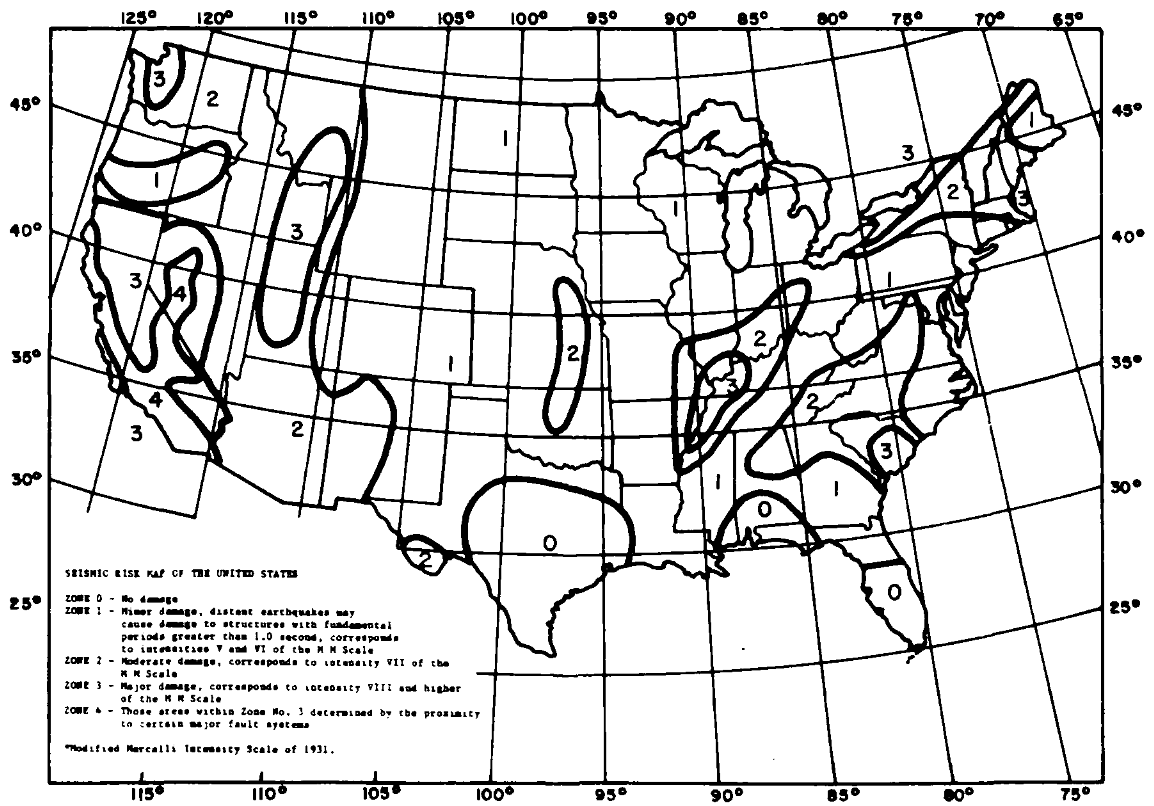


Figure 8. Seismic risk map of the contiguous United States. (Reproduced from the 1979 edition of the Uniform Building Code with permission of the publisher, the International Conference of Building Officials.)

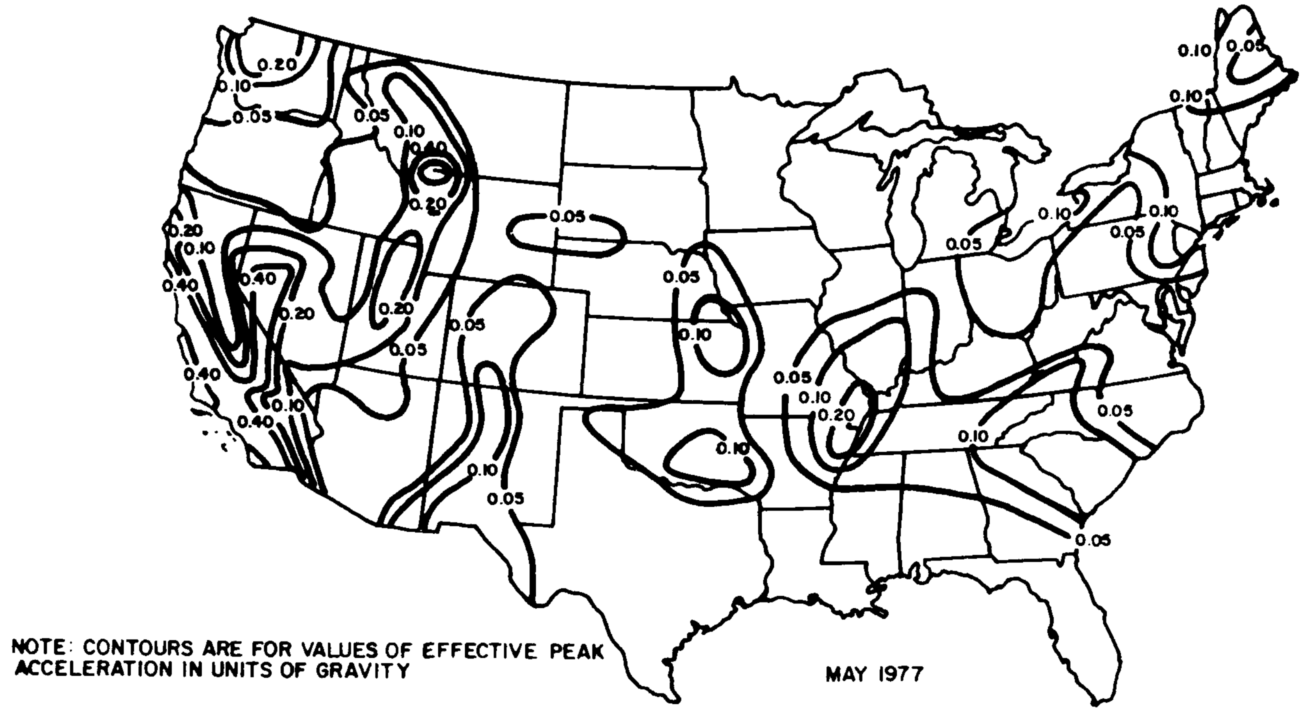


Figure 9. Contour map of effective peak acceleration (EPA) for the 48 contiguous states. (Contours represent EPA levels with non-exceedance probability of between 80 and 95 percent during 50-year period.) (Reprinted with permission from N. C. Donovan, B. A. Bolt, and R. V. Whitman, "Development of Expectancy Maps and Risk Analysis," ASCE, Journal of Structural Division, Vol 104, No. St 8 (1978), pp 1179-1192.)

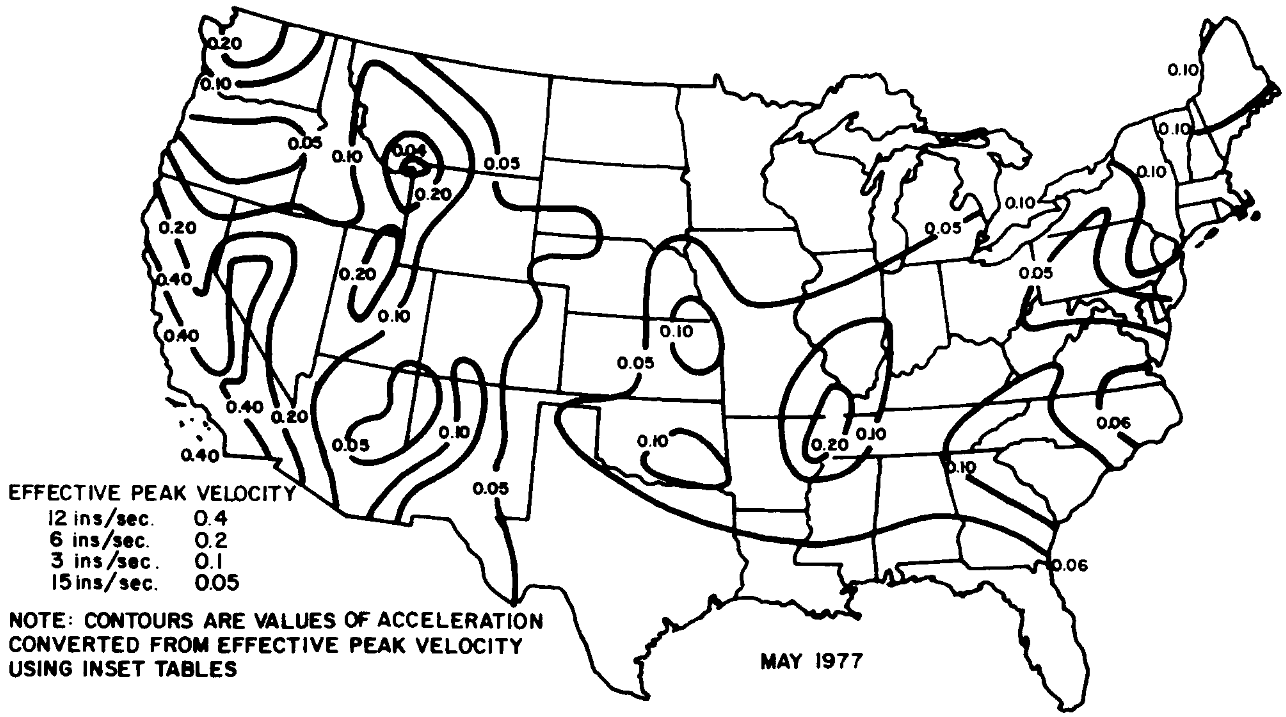


Figure 10. Contour map of effective peak velocity-related acceleration (EPV) for 48 contiguous states. (Contours represent values based on velocity but have been expressed equivalent to acceleration for use in developing lateral design forces.) (Reprinted with permission from N. C. Donovan, B. A. Bolt, and R. V. Whitman, "Development of Expectancy Maps and Risk Analysis," ASCE Journal of the Structural Division, Vol 104, No. St 8 (1978), pp 1179-1192.

While these maps are a marked improvement over the seismic zone maps shown in Figures 7 and 8, they have not been officially adopted by the Army. Therefore, for the purpose of this investigation, the seismic zone maps in TM 5-809-10 (1980 Draft Edition) will be adopted for indexing the ground shaking hazard. Tables 14 and 15 give the appropriate seismic zone for each of the 164 Army installations and major activities.

Building Response and Damage

Earthquake ground motions are transmitted to a building through its foundation when the foundation is set in motion and the rest of the building is forced to move and respond. The complex vibratory motion which follows is a function of the dynamic properties of the ground motion (e.g., frequency content, duration, acceleration level, etc.) and the dynamic characteristics of the building (e.g., natural frequencies of vibration, mode shapes or characteristic patterns of vibration at each of the natural frequencies, and damping). The building's physical properties, such as weight (mass), stiffness, damping, etc., determine the building's dynamic characteristics. The way these properties affect a building's dynamic characteristics and ultimately its response is discussed below:

1. Mass. A building's mass influences its period of vibration. If the predominant periods of the building are close to the predominant periods of the input motions, the building's response may be amplified. The distribution of the mass within the building also has important effects on its response. Uneven or assymmetrical distribution of the mass will cause the building to respond with motions that include torsion as well as translations.

2. Stiffness. Stiffness will also influence the period of the building. A building's overall stiffness is dependent upon the material stiffness of its components: its configuration (i.e., number of stories, general form in plan and elevation, and geometry of various systems and components); and the type of connections between the components. This stiffness will determine the building's mode of response during an earthquake. Flexible buildings will undergo large deformations and relative movements, while stiff buildings generally experience small deformations. In addition, a building may exhibit torsional motions because various parts of a building are stiffer than others.

3. Damping. A building's damping property is related to the degree to which it will dissipate energy. Damping is the measure of the building's resistance to continued vibration and is determined by all its materials and finishes. Buildings with many partitions, ceilings, and ductile finishes tend to have higher damping coefficients than buildings with fewer components. Damping is a major factor in determining building response, because the higher the damping coefficient, the smaller the acceleration for which the building must be designed.

A building's mass, stiffness, and damping characteristics are a function of several other factors such as those discussed below.

Table 14

Seismic Zone Tabulation for Army Installations and Major Activities in the Continental United States

Installation or Major Activity	Seismic Zone
Aberdeen Proving Ground	1
Anniston Army Depot	2
Arlington Hall Station	1
Army Materials and Mechanics Research Center	3
Army Topographic Station	1
Baker, Fort	4
Ballistics Missile Defense Advanced Tech. Center	1
Belvoir, Fort	1
Benning, Fort	1
Bliss, Fort	2
Blue Grass Depot Activity	1
Bragg, Fort	1
Brooke Army Medical Center	0
Bullis Camp	0
Cameron Station	1
Campbell, Fort	2
Carlisle Barracks	1
Carson, Fort	1
Catalog Data Activity	1
Chaffee, Fort	1
Coosa River	2
Corpus Christi Army Depot	0
Crane Army Ammunition Activity	2
DARCOM Ammunition Center	1
Defense Construction Supply Center	1
Defense General Supply Center	1
Defense Personnel Support Center	2
Detrick, Fort	1
Detroit Arsenal	1
Devens, Fort	2
Diamond, Harry Laboratories	1
Dix, Fort	1
Drum, Fort	2
Dugway Proving Ground	2
Dwight David Eisenhower Army Medical Center	2
Electronic R&D Command	1
Eustis, Fort	1
Fitzsimmons Army Medical Center	1
Frankford Arsenal	2
Gateway Army Ammunition	2

Table 14 (Cont'd)

Installation or Major Activity	Seismic Zone
Gillem, Fort	2
Gordon, Fort	2
Gulf Outport	1
Hamilton, Fort	2
Harrison, Fort Benjamin	2
Hawthorne Army Ammunition Plant	4
Hayes Army Ammunition Plant	1
Hill, Fort AP	1
Holston Army Ammunition Plant	2
Hood, Fort	0
Houston, Fort Sam	0
Huachuca, Fort	2
Hunter Army Airfield	2
Indiana Army Ammunition Plant	2
Indiantown Gap, Fort	1
Iowa Army Ammunition Plant	1
Irwin, Fort	4
Jackson, Fort	2
Jefferson Proving Ground	2
Joliet Army Ammunition Plant	1
Kansas Army Ammunition Plant	1
Knox, Fort	2
Lake City Army Ammunition Plant	2
Leavenworth, Fort	2
Lee, Fort	1
Letterkenny Army Depot	1
Letterman Army Medical Center	4
Lewis, Fort	3
Lexington-Blue Grass Depot Activity	1
Liggett, Fort Hunter	4
Lima, US Army Modification Center	2
Lone Star Army Ammunition Plant	1
Longhorn Army Ammunition Plant	1
Louisiana Army Ammunition Plant	1
MacArthur, Fort	4
Madigan Army Medical Center	3
McAlester Army Ammunition Plant	2
McClellen, Fort	2
McCoy, Fort	1
MacKall, Camp	1
McNair, Fort Lesley J.	1
McPherson, Fort	
Meade, Fort George G.	1

Table 14 (Cont'd)

Installation or Major Activity	Seismic Zone
Memphis Defense Depot	3
Michigan Army Missile Plant	1
Milan Army Ammunition Plant	2
Mississippi Army Ammunition Plant	0
Monmouth, Fort	2
Monroe, Fort	1
Monterey, Presidio of	4
Myer, Fort	1
Natick Research and Development Center	2
Navajo Depot Activity	1
New Cumberland Army Depot	1
Oakdale Support Center	1
Oakland Army Base	4
Ogden Defense Depot	3
Ord, Fort	4
Parks, Camp	4
Phosphate Development Works	1
Picatinny Arsenal	2
Pickett, Fort	1
Pine Bluff Arsenal	2
Polk, Fort	1
Pueblo Army Depot Activity	1
Radford Army Ammunition Plant	2
Ravenna Army Ammunition Plant	1
Red River Army Depot	1
Redstone Arsenal	2
Riley, Fort	2
Ritchie, Fort	1
Riverbank Army Ammunition Plant	3
Roberts, Camp	4
Rock Island Arsenal	1
Rocky Mountain Arsenal	
Rucker, Fort	0
Sacramento Army Depot	3
Saginaw Army Aircraft Plant	0
St. Louis Army Ammunition Plant	2
St. Louis Area Support Center	2
San Francisco, Presidio of	4
Savannah Army Depot Activity	1
Scranton Army Ammunition Plant	2
Seneca Army Depot	2
Sharpe Army Depot	3
Sheridan, Fort	1
Sierra Army Depot	3

Table 14 (Cont'd)

Installation or Major Activity	Seismic Zone
Sill, Fort	2
South Atlantic Outport	3
Southern California Outport	4
St. Louis Area Support Center Illinois	2
Stanley, Camp Storage Activity	0
Stewart, Fort	1
Story, Fort	1
Stratford Army Engine Plant	2
Sunny Point Military Ocean Terminal	1
Tarcom Support Activity Selfridge	1
Tarheel Army Missile Plant	2
Tobyhanna Army Depot	2
Tooele Army Depot	3
Twin Cities Army Ammunition Plant	1
Umatilla Depot Activity	2
United States Military Academy	2
Vancouver Barracks	1
Vint Hill Farms Station	1
Volunteer Army Ammunition Plant	2
Wadsworth, Fort	1
Walter Reed Army Medical Center	1
Watervliet Arsenal	2
West Point Military Reservation	2
White Sands Missile Range	2
William Beaumont Army Medical Center	2
Wingate Depot Activity, Fort	1
Wood, Fort Leonard	1
Yakima Firing Center	2
Yuma Proving Ground	4

Table 15

Seismic Zone Tabulation for Army Installations and Major Activities in Alaska and Hawaii

Major Activities in Alaska and Hawaii

Installation or Major Activity	Seismic Zone
Alaska	
Greely, Fort	3
Richardson, Fort	4
U.S. Army Medical Dept. Activity	3
Wainwright, Fort	3
Hawaii	
Pohakuloa Training Area	3
Schofield Barracks	2
Tripler Army Medical Center	2
Wheeler Army Airfield	2

1. Construction Materials. Different materials display varying inelastic behavior. Ductile materials, such as steel, have an extended inelastic range in which they can undergo permanent deformations without rupture. On the other hand, brittle materials, such as brick, masonry, and plain concrete, display almost no inelastic behavior under loading, and experience sudden failures at or near the elastic limit. A material's ability to absorb energy while undergoing inelastic deformation without failure is termed ductility. Ductility can be thought of as providing a quality of toughness which, to a large extent, determines a building's survivability under earthquake conditions. Without proper reinforcement, brick, masonry, and concrete have low ductility values and are very susceptible to failure during an earthquake.

2. Structural System. Another important factor affecting building performance during an earthquake is the lateral-force resisting elements of a building's structural system. The structural system must transmit the lateral forces by horizontal diaphragm action of the roof and floor systems to the vertical resisting elements (ductile moment resisting space frame, shear walls, or braced frames) and down to the foundation. The rigidity of the diaphragms is very important. Rigid diaphragms tend to reduce the effects of unsymmetrical forms and structural features, because more torsional resistance can be developed. Flexible diaphragms may permit portions of the building to vibrate out of phase with the rest of the building, creating major torsional and displacement problems. Foremost among the requirements is the necessity for the building to be tied together as a unit, with all connections having adequate capacity for load transfer by shear, tension, compression, or moment, as applicable.

For the purpose of seismic analysis and design, building structural systems can be grouped into four general categories: bearing wall system, building frame system, moment-resisting frame system, and dual system.

a. A bearing wall system refers to a structural support system in which major load-carrying columns are omitted and the walls and/or partitions are strong enough to carry the loads. The walls and partitions supply lateral stiffness and stability to resist earthquake loading and other lateral loadings. During past earthquakes, failures in the bearing wall system have frequently been caused by a lack of redundancy in the vertical and horizontal load support.

b. A building frame system carries the gravity loads primarily by a frame supported on columns rather than bearing walls. Lateral resistance is provided by nonbearing structural walls or braced frames. Generally, past performance of this structural system has been better than the bearing wall system.

c. A moment-resisting frame system, like the building frame system, has a complete frame. However, in this system, the lateral resistance is provided by moment-resisting connections between columns with interacting beams or girders.

d. A dual system consists of a space frame made up of columns and beams which provide support for the gravity loads. Lateral resistance is supplied by structural nonbearing walls or bracing. The frame has a redundant lateral force system capable of resisting at least 25 percent of the specified earthquake lateral forces. Past performance has indicated that this system is one of the most effective structural systems for resisting lateral forces.

3. Building configuration. Irregularities in the plan and vertical configurations can radically change a building's dynamic behavior.

a. Plan configuration. Plan configuration irregularities affect the diaphragm forces and the distribution of the inertial forces to the vertical components of the lateral force-resisting system. Pure symmetry in plan does not necessarily guarantee well-balanced response of a building. Buildings with H- or cruciform-shaped plans are symmetrical, yet the response of the wings of these buildings is generally different from the response of the building as a whole, and produces high stress concentrations at the re-entrant corners. Likewise, a stiff core located off center in the plan causes the center of rigidity not to coincide with the center of mass, and this increases torsional effects. Some common irregularities in plan include the following:

(1) Mass and resistance eccentricity

(2) Discontinuity in the diaphragm stiffness

(3) Geometric irregularities, such as +, H, U, E, T, and L shapes

(4) Core-type layouts.

b. Vertical configuration. Uniformity in a building's vertical configuration is also very important. Vertical configuration irregularities affect the response of various levels of a building and may impose loads at these levels which can be significantly different from those obtained by normal assumptions. Irregularities in the vertical configuration are created by the following features:

(1) Unsymmetrical vertical geometry with respect to the vertical axis of the building

(2) Setbacks at one or more levels

(3) Significant changes in the mass-to-stiffness ratio in adjoining levels

c. Structural features. Other structural features which may adversely affect the structure's response include:

(1) Discontinuities in the vertical and lateral load-resistance systems

(2) Nonredundant systems

(3) Lack of ties and continuity

(4) Lack of collector elements.

4. Foundation. The basic principle of earthquake engineering is that the buildings should act as an integral unit, and that there should be adequate load paths for carrying the lateral forces down to the foundation. Ultimately, the foundation must transfer the lateral forces to the subsoil, resist overturning effects from the lateral forces, resist the vertical gravity loadings, and provide sufficient reserve strength to deal with some of the differential ground movements. Continuous rafts and box foundations generally have adequate strength and stiffness to resist differential settlement.[8]

5. Nonstructural components. Recent earthquakes have demonstrated that the cost of damage to nonstructural components can be excessive. Moreover, earthquake damage studies have shown that the placement of nonstructural elements on or in a building may significantly affect the structure's seismic response. Some of the factors that cause damage are discussed below.

a. Architectural elements. Damage to architectural elements can result in both significant dollar losses and hazards to occupants. For example, stairways have been blocked by the collapse of surrounding partitions or wall claddings. There have been widespread collapses of suspended ceilings with light "T" bar metal runners and splined or lay-in acoustical tiles. In addition, building elements without intended structural function, such as unfill walls, partitions, curtain walls, suspended ceilings, and surface finishes, may interact with the structural system. The interaction of the architectural element with the structural system, exterior treatment and elements, and interior treatment and elements are all important items that could potentially cause damage and loss of life.

---

[8] D. J. Dowick, Earthquake Resistant Design (John Wiley, 1977), p 90.

b. Elevators and stairways. Damage to building exits is a common problem, particularly when stairways are blocked by surrounding partitions and elevators are rendered inoperable due to lack of electrical power and/or damage to the equipment. Elevator counterweights are frequently thrown out of their guide system because of inadequate strength in the guides or the nature of their attachments to the structural frame.

c. Mechanical, electrical, and plumbing. Insufficient attention has been given to the lateral force design for equipment or to its anchorage and bracing. Equipment has often been placed on vibration isolators that are inadequate to resist strong earthquake motions. Suspended electrical light fixtures have proved vulnerable to earthquake motions, except for those systems incorporating specially developed restraining systems. Equipment that has been adequately bolted to concrete floors and foundations and which has adequate supports has performed satisfactorily.

Indexing Hazardous Buildings

Based on lessons learned from past earthquakes and in the interest of simplicity, it appears that two fundamental parameters can define the potential hazardousness of an existing building: a structural system index and an importancy index. The structural system index reflects the type of lateral force-resisting system in the building, including the type of materials from which it is constructed, such as reinforced masonry, load-bearing wall systems; reinforced concrete, ductile, moment-resisting frames; or light steel x-braced frame. The basic structural system index can be modified by weighting factors to account for additional elements (e.g., number of stories, irregularities in the plan and vertical configuration, foundation system, etc.) as such information becomes available. The importancy index reflects both the building's occupancy potential and its post-earthquake operational requirements. The importancy index can be modified by weighting factors to account for such factors as cost and size of the building.

Based on the information available in the RPI, there does not seem to be a good basis for correlating a structural system 'ex. The type of wall material is hardly sufficient information on which to judge the required type of lateral force-resisting structural system. For example, concrete walls could be cast-in place concrete shear walls or precast concrete wall panels. The behavior of these two systems is radically different. Moreover, in reviewing the detailed RPI for Fort Ord, CA, it was noted that in several instances, a building's type of wall material was not specified. With some additional research and field data, it may be possible to formulate a more rational scheme for characterizing the structural system index.

It appears that the RPI and BIS systems contain enough information for the importancy index. The likely occupancy of many of the buildings is given or can be calculated on the basis of the total area of the building and the number of square feet per occupant. The latter must be established on the basis of engineering judgment and modified on the basis of field experience. In addition, the building area and the acquisition cost can be used as weighting factors.

4 SEISMIC HAZARD PRIORITY-RANKING CONCEPT FOR BUILDINGS

Basic Philosophy

Since the Army has a huge inventory of buildings, it must have an effective strategy to identify the ones that present potentially unacceptable seismic hazards in order to perform seismic safety evaluations of potentially hazardous buildings on a priority basis. The degree of sophistication of a concept for identifying potentially hazardous buildings is at least initially dependent on information and data in the RPI or BIS or in data that can be developed with a minimal expenditure of time and funds. It is not practical for the Army to resurvey its existing inventory of buildings to collect additional data for a detailed analytical evaluation that would probably require a dynamic analysis of each building. The seismic hazard priority-ranking procedure must be structured to provide meaningful information without such detailed data; however, it should use detailed safety data to provide more refined estimates of the potential seismic hazard if it is available or becomes available during the preliminary seismic safety evaluations or in conjunction with modernization projects.

Basically, the objectives in formulating the seismic hazard priority-ranking procedure are:

1. To produce meaningful results which are as simple as possible, considering the existing databases.

2. To minimize the amount of data required for meaningful results, i.e., the database should contain only the most fundamental building characteristics.

3. To provide an orderly means of associating the building characteristics with hazard potential.

4. To provide a database structure that can accommodate additional detailed data if and when it becomes available in order to refine or update the seismic vulnerability index value.

Basic Concept

The basic concept for the seismic hazard priority-ranking procedure is based on calculating a seismic vulnerability index that reflects a building's relative potential seismic hazard. The index is calculated from factors associated with the seismic exposure, the building's structural characteristics, and aspects of the building which reflect the importance of the building. The basic algorithm for calculating the seismic vulnerability index is:

$$SVI = f(EI*SSI*II) \qquad \text{[Eq 1]}$$

where

SVI = seismic vulnerability index

EI = exposure index

SSI = structural system index

II = importancy index

f = proportioning function

The seismic vulnerability index has a range of value between 0 and 100. The closer the value is to 100, the greater the likelihood is of significant damage to the building or loss of life. Likewise, the exposure index, the structural system index, and the importancy index all have values ranging between 0 and 100. Within a given population of buildings, the building with the greatest potential hazard (i.e., the largest numerical value for the product of the exposure index, structural system index, and importancy index) is assigned a seismic vulnerability index value of 100 and the seismic vulnerability index value for other buildings in the population is proportioned accordingly.

The exposure index represents the level of anticipated strong motion shaking at the building's location, and it can be modified by subjective weighting factors for the effects of site-structure resonance conditions, potential liquefaction, landslides, surface faulting, differential settlement, tsunamis, etc. For Army installations in the United States, the exposure index value can be based on the coefficient in Table 16 that corresponds to the appropriate seismic zone tabulated in Tables 14 and 15. Initially, most of the associated weighting factors will have a value of zero, since the effects of many of these secondary hazards have not been indexed in a meaningful way.

The structural system index represents the level of anticipated performance of the building's structural system, and it can be modified by subjective weighting factors for the effects of irregularities in plan and vertical

Table 16

Basic Exposure Index

Seizmic Zone	0	1	2	3	4
Coefficient	0	3/16	3/8	3/4	1

configuration, foundation type, number of stories, redundancy of structural members, etc. The index is a function of both the type of structural system and the materials comprising it. Initially, the structural system index can be assigned a value based on the data for wall material in the RPI or the structural material in the BIS. However, a more rational method for characterizing the structural performance is needed if the results are to be meaningful. Likewise, many of the weighting factors associated with the structural system index will have a value of zero, since many of these structural features have yet to be indexed in a meaningful way.

The importancy index represents the relative importance of the building either in terms of or post-disaster recovery requirements or potential occupancy. Typical examples of buildings with post-disaster recovery requirements are:

(1) Hospitals

(2) Fire stations, rescue stations, and garages for emergency vehicles

(3) Power stations and other utilities required as emergency facilities

(4) Mission-essential and primary communication or data-handling facilities

(5) Facilities involved in operational missile control, launch, tracking, or other critical defense capabilities

(6) Facilities involved in handling, processing, or storing sensitive munitions, nuclear weaponry or processes, gas and petroleum fuels, and chemical or biological contaminants.

High potential-occupancy buildings are those where primary occupancy is for assembly of a large number of people, or where services are provided to a large area having many other buildings. Buildings in this category may suffer damage in a large earthquake but are recognized as warranting a higher level of safety than the ordinary building. Typical examples are:

(1) Buildings whose primary occupancy is that of an auditorium, recreation facility, dining hall, or commissary which is subject to occupancy by more than 300 persons

(2) Confinement facilities

(3) Central utility (power, heat, water, sewage) that are not required as emergency facilities and that serve large areas

(4) Buildings having high value equipment whose justification is provided by the using agency.

All other buildings not covered by the categories listed above are considered ordinary buildings requiring no special consideration.

The importancy index can be modified by weighting factors for the effects of occupancy or the building's basic acquisition cost area, historical value, etc.

One of the major purposes of the seismic hazard priority-ranking procedure is to provide a tool to help Army personnel decide which buildings require seismic safety evaluations, and in what order to proceed through the inventory. The ranking process for achieving this goal is structured on the concept that a building's relative position in a priority list can be based on an accumulation of "points." The points are determined from the relative magnitude of various factors and weights assigned to them. The weights measure the relative importance of each factor, i.e., the higher the weight, the more points are accumulated for a building's position in the overall ranking. The following example illustrates the procedure.

Suppose the importancy index for three buildings designated A, B, and C is to be calculated on the basis of the relative importance of the building and three weighting factors: occupancy, cost, and area. Building A is a fire station with specific post-disaster recovery requirements. Buildings B and C are used for training and administrative purposes, respectively, but neither has any post-disaster recovery requirements. For purposes of this example, assign Building A a basic index of 2.0 and Buildings B and C a basic index of 1.0. Similarly, assign a weight of 4 to "occupancy," 3 to "area," and 2 to "cost." The steps in the ranking process are as follows:

a. Step 1: Store the building identifiers and relevant data in a table.

Building	Occupancy	Area	Cost
A	15	9,900	296
B	92	11,400	252
C	30	22,000	317

b. Step 2: Sort on the occupancy factor. Use an ascending order so that the largest occupancy is last in the sort and has the largest rank number.

Building	Occupancy	Area	Cost
A	15	9,900	296
C	30	22,000	317
B	92	11,400	252

c. Step 3. Assign a rank order to the occupancy factor.

Building	Occupancy	Area	Cost
A	1	9,900	296
C	2	22,000	317
B	3	11,400	252

d. Step 4. Sort on the area factor.

Building	Occupancy	Area	Cost
A	1	9,900	296
B	3	11,400	252
C	2	22,000	317

e. Step 5: Assign a rank order to the area factor.

Building	Occupancy	Area	Cost
A	1	1	296
B	3	2	252
C	2	3	317

f. Steps 6 and 7: Sort and assign rank order for the cost factor.

Building	Occupancy	Area	Cost
A	1	1	2
B	3	2	1
C	2	3	3

g. Step 8: Calculate the numbers of raw points for each parameter, and subtotal the raw points for each building.

	Raw Points			
Building	Occupancy	Area	Cost	Subtotal
A	1x4=4	1x3=3	2x2=4	4+3+4=11
B	3x4=12	2x3=6	1x2=2	12+6+2=20
C	2x4=8	3x3=9	2x3=6	8+9+6=21

h. Step 9: Multiply the subtotal of the raw points for each building by the basic index to obtain the total raw points for each building.

Building	Subtotal	Basic Index	Total
A	11	2.0	22
B	20	1.0	20
C	21	1.0	21

i. Step 10: Assign the importancy index for each building based on Building A receiving a value of 100, and proportion the values for Buildings C and B accordingly.

Building	Importancy Index
A	22/22 (100) = 100
C	21/22 (100) = 95
B	20/22 (100) = 91

Based on the factors and weights specified in this example, Building A would warrant first priority, followed by Buildings C and B, respectively.

Trial Application

A trial application of the ranking concept was performed using a subset of the existing buildings at Fort Ord, CA. The subset was obtained by screening the inventory of real property for Fort Ord and excluding all items except buildings having an area greater than 3000 sq ft (270 m^2), and an acquisition cost greater than \$200 K. Of the 3620 buildings at Fort Ord, 127 met the specified criteria. The Appendix lists these buildings by category code.

Since all the buildings were located at one installation, the exposure index was the same for all buildings. Moreover, due to the lack of definitive information regarding the buildings' structural systems, the structural system index was assumed to be the same for all buildings. Computation of the importancy index involved modifying the basic index by weighting factors for occupancy potential, building area, and acquisition cost. To establish a potential occupancy level for some of the buildings, it was necessary to establish values for the number of square feet per occupant. These values were established on the basis of engineering judgment; Table 17 lists the specific values used for this application by facility class. Subsequently, buildings were ranked in accordance with the process outlined in the previous section.

Each of the 127 buildings was sorted on the basis of potential occupancy, area, and acquisition cost; then, each building was assigned a rank from 1 to 127 for each factor. Where identical buildings such as enlisted personnel barracks were encountered, the rank assigned to each building was the average of the number of total ranked points for the entire group of identical buildings. For example, if three buildings were tied for fifth place, each was assigned a rank of 6, and the fifth and seventh positions were eliminated. Weighting factors of 4 for "potential occupancy," 3 for "area," and 2 for "acquisition cost" were assigned. Buildings with potential post-disaster recovery requirement, or having high occupancy were assigned basic indices of 1.5 and 1.25, respectively. The calculations were performed manually, following the procedure outlined in the example calculation.

Table 18 lists the ten buildings with the highest ranking based on the importancy index. This listing is presented to illustrate the potential results of a seismic hazard priority-ranking procedure, and should not be construed as a final ranking of the potentially hazardous buildings at Fort Ord, CA. The basic concept is still under development in many areas, particularly with regard to finding a more rational scheme to characterize the structural performance of buildings based on the limited data contained in the RPI and BIS.

Table 17

Square Feet Per Occupant

(Metric Conversion Factor: 1 sq ft = .09 m^2)

Facility	Sq Ft/Occupant
Telephone Exchange	1000
Regimental Brigade Headquarters	300
Aircraft Instrument Trainer	100
Battalion Administration and Classroom	100
Maintenance Aircraft Hangar, Organizational	2000
Field Maintenance Aircraft Hangar	2000
Motor Repair Shop	1000
Maintenance Shop, General Purpose	2000
Aircraft Accountable Parts suppls	2000
General-Purpose Storage	2000
General Storage Family Housing	6000
Hospital	500
Dental Clinic	1000
Administration Building, General Purpose	300
Enlisted Personnel Mess	60
Administration and Supply	2000
Confinement Facility	500
Fixed Laundry	1500
Bowling Center	500
Commissary	200
Gymnasium	100
Library, Main	1000
Open Mess, NCO	100
Open Mess, Officers	100
Exchange, Main	200
Post Office, Main	2000
Enlisted Men's Service Club	100
Indoor Swimming Pool	200
Sewage Treatment Plant	1000

Table 18

List of Facilities Ranked by Priority

Facility		Building/Facility Number
1	Hospital	4385
2	Commissary	4240
3	Enlisted Men's Service Club	2075
4	Open Mess NCO	4260
5	Confinement Facility	4953
6	Exchange Main Retail Store	4235
7	Enlisted Personnel Mess	3641
8	Post Chapel	4280
9	Enlisted Men's Service Club	4600
10	Enlisted Personnel Barracks	4552

5 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of the study, some general conclusions and recommendations can be made.

The basic concept for the seismic hazard priority-ranking procedure appears to satisfy the objectives of requiring a minimum amount of information and relating a building's characteristics to the seismic hazard in an orderly manner. Although the basic concept has the potential to provide meaningful results, this is not yet a certainty. Realistically, this can be evaluated only after further development of the concept and comparing more comprehensive trial evaluations with actual experience at installations.

The current RPI and BIS databases do not adequately describe the buildings' structural systems or the structural materials that comprise them; this information is necessary to meet the needs and requirements of the seismic hazard priority-ranking concept. The RPI and BIS databases should be modified to incorporate a more suitable description of the buildings' structural systems and the materials comprising them.

In addition, further development of the seismic hazard priority-ranking concept is necessary to refine the basic index values, to establish weighting factor values, and to automate the concept.

REFERENCES

Construction Criteria Manual, DOD 4270.1-M (Department of Defense, June 1978).

Department of the Army Facility Classes and Construction Categories, AR 415-28 (Department of the Army, August 1973).

Donovan, N. C., B. A. Bolt, and R. V. Whitman, "Development of Expectancy Maps and Risk Analysis," ASCE, Journal of the Structural Division, Vol 104, No. St 8 (1978), pp 1179-1192.

Dorwick, D. J., Earthquake Resistant Design (John Wiley, 1977), p 90.

Inventory of Army Military Real Property (Department of the Army, 30 September 1979).

Master Planning for Army Installations, AR 210-20 (Department of the Army, 26 June 1976).

Natural Hazards Evaluation of Existing Buildings, NBS B5561 (National Bureau of Standards, January 1975).

Seismic Design for Buildings, TM 5-809-10, Draft Edition (Department of the Army, 1980).

Uniform Building Code (International Conference of Building Officials, 1979).

United States Army Installations and Major Activities, DA Pam 210-1 (Department of the Army, February 1980).

APPENDIX: SUBSET OF EXISTING BUILDINGS AT FORT ORD, CA

SCREENED INVENTORY OF MILITARY REAL PROPERTY AT (ORD FORT)

AS OF DATE 063080

CATEGORY CODE FORMAT #3

SCREENING PARAMETERS

MINIMUM AREA, SQ FT ------------- (3000).
EARLIEST ACQUISITION/BUILT,YR --- (1980).
MINIMUM ACQUISITION COST, $K --- (200).

CATEGORY CODE	CATEGORY DESCRIPTION	TYPE CONST	BUILDING / FACILITY NO	ACQUISITION COST ($K)	TOTAL AREA	UNIT MEASURE	YEAR BUILT	NUMBER FLOORS	WALL MATERIAL	TOTAL CAPACITY	UNIT MEASU
13180	TEL EXCH BLDG	P	04250	289	13088	SF	53	3	C	0	
14186	RGT/BDE HQ BLDG	P	04463	202	9797	SF	70	3	D	0	
17110	AC TRAINER BLDG	P	00921	655	7222	SF	78		G	0	
17150	BN CLASSROOMS	P	04800	4130	5627	SF	54			0	
17151	BN ADM - CLRM	P	03628	248	5880	SF	77	1	H	0	
17151	BN ADM - CLRM	P	03629	352	5820	SF	78		H	0	
17151	BN ADM - CLRM	P	03630	352	5820	SF	78		H	0	
21110	MNT AC HQ ORG	P	00510	465	21497	SF	59	2	C	0	
21110	MNT AC HQ ORG	P	00524	814	38007	SF	61	2	C	0	
21110	MNT AC HQ ORG	P	00527	2084	39446	SF	77	2		0	
21114	FL MNT AC HQ	P	00507	2045	64920	SF	78	2	C	0	
21114	FL MNT AC HQ	P	00533	756	35000	SF	63	2	C	0	
21410	MOTOR REP SHOP	P	00509	289	5300	SF	77	2		0	
21410	MOTOR REP SHOP	P	01483	720	15592	SF	77	2		0	
21410	MOTOR REP SHOP	P	01489	673	14578	SF	77			0	
21410	MOTOR REP SHOP	P	01495	583	12634	SF	77	2	C	0	
21410	MOTOR REP SHOP	P	04495	411	8682	SF	77	2	D	0	
21410	MOTOR REP SHOP	P	04499	684	14535	SF	77	2		0	
21410	MOTOR REP SHOP	P	04506	684	14520	SF	77	2		0	
21410	MOTOR REP SHOP	P	04512	684	14517	SF	77	2		0	
21410	MOTOR REP SHOP	P	04538	498	12006	SF	77	2	D	0	
21410	MOTOR REP SHOP	P	04544	531	12820	SF	77	2	[illegible]	0	

SCREENED INVENTORY OF MILITARY REAL PROPERTY AT (ORD FORT I)

AS OF DATE 063080

CATEGORY CODE FORMAT #8

SCREENING PARAMETERS

MINIMUM AREA, SQ FT ------------ (3000).
EARLIEST ACQUISITION/BUILT,YR --- (1980).
MINIMUM ACQUISITION COST, $K ---- (200).

CATEGORY CODE	CATEGORY DESCRIPTION	TYPE CONST	BUILDING / FACILITY NO	ACQUISITION COST ($K)	TOTAL AREA	UNIT MEASURE	YEAR BUILT	NUMBER FLOORS	WALL MATERIAL	TOTAL CAPACITY	UNIT MEASU
21410	MOTOR REP SHOP	P	04548	337	8128	SF	77	2	D	0	
21885	MVT SH GEN PURP	P	04900	320	23296	SF	56	1	C	0	
44211	AC ACC PTS SUPL	P	00535	341	27456	SF	63			0	
44220	GEN PURP WHSE	P	02063	246	31223	SF	52	1	C	0	
44271	GEN STOR FH	T	02450	201	24180	SF	41	1	A	0	
51010	HOSPITAL	P	04385	15257	366589	SF	71	8	C	440	BD
54010	DENTAL CLINIC	P	04399	1235	15524	SF	77	2	D	28	OU
54010	DENTAL CLINIC	P	04787	460	12743	SF	64	1	D	28	OU
61050	ADM GEN PURP	P	02798	215	37945	SF	41	2	A	0	
71124	FH CAPE CG - WO	P	06300	337	3379	SF	59	1		2	FA
71124	FH CAPE CG - WO	P	06301	337	8379	SF	59	1		2	FA
72110	EM BKS W/MESS	P	04430	446	42017	SF	54	4	D	143	MN
72110	EM BKS W/MESS	P	04432	344	40653	SF	54	4	D	143	MN
72110	EM BKS W/MESS	P	04434	344	40653	SF	54	4	D	143	MN
72110	EM BKS W/MESS	P	04436	344	40653	SF	54	4	D	143	MN
72110	EM BKS W/MESS	P	04440	700	42017	SF	54	4	D	143	MN
72110	EM BKS W/MESS	P	04442	347	40653	SF	54	4	D	143	MN
72110	EM BKS W/MESS	P	04444	344	40653	SF	54	4	D	143	MN
72110	EM BKS W/MESS	P	04446	347	40653	SF	54	4	D	143	MN
72111	EM BK W/O MS	P	04471	784	40587	SF	70	3		194	MN
72111	EM BK W/O MS	P	04472	784	40587	SF	70	3	D	194	MN
72150	OTHER	P	03620	1064	22439	SF	77	3	H	110	MN

SCREENED INVENTORY OF MILITARY REAL PROPERTY AT (ORD FORT I)

AS OF DATE 063080

CATEGORY CODE FORMAT #3

SCREENING PARAMETERS

MINIMUM AREA, SQ FT ------------- (3000)*
EARLIEST ACQUISITION/BUILT,YR --- (1980)*
MINIMUM ACQUISITION COST, $K ---- (200)*

CATEGORY CODE	CATEGORY DESCRIPTION	TYPE CONST	BUILDING / FACILITY NO	ACQUISITION COST ($K)	TOTAL AREA	UNIT MEASURE	YEAR BUILT	NUMBER FLOORS	WALL MATERIAL	TOTAL CAPACITY	UNIT MEASU
72150	OTHER	P	03621	1064	22439	SF	77	3	H	110	MN
72150	OTHER	P	03623	1064	22439	SF	77	3	H	110	MN
72150	OTHER	P	03625	701	22439	SF	78	3	H	110	MN
72150	OTHER	P	03627	701	22489	SF	78	3	H	110	MN
72150	OTHER	P	03631	701	22439	SF	78	3	H	110	MN
72150	OTHER	P	03632	701	22489	SF	78	3		110	MN
72150	OTHER	P	03635	701	22439	SF	78	3	H	110	MN
72150	OTHER	P	03636	701	22439	SF	78	3		110	MN
72150	OTHER	P	03638	701	22439	SF	78	3	H	110	MN
72150	OTHER	P	04386	615	19011	SF	74	3	C	134	MN
72150	OTHER	P	04387	615	19011	SF	74	3	C	115	MN
72150	OTHER	P	04451	785	40587	SF	70	3	D	194	MN
72150	OTHER	P	04452	785	40587	SF	70	3	D	194	MN
72150	OTHER	P	04454	785	40587	SF	70	3		194	MN
72150	OTHER	P	04456	785	40587	SF	70	3	D	194	MN
72150	OTHER	P	04457	785	40587	SF	70	3	D	194	MN
72150	OTHER	P	04466	785	40587	SF	70	3	D	194	MN
72150	OTHER	P	04467	785	40587	SF	70	3	D	194	MN
72150	OTHER	P	04469	785	40587	SF	70	3		194	MN
72150	OTHER	P	04552	1274	42017	SF	54	4	D	132	MN
72150	OTHER	P	04554	1000	40653	SF	54	4	D	132	MN
72150	OTHER	P	04556	1132	40653	SF	54	4	D	132	MN

SCREENED INVENTORY OF MILITARY REAL PROPERTY AT (ORD FORT)

AS OF DATE 063080

CATEGORY CODE FORMAT #8

SCREENING PARAMETERS

MINIMUM AREA, SQ FT ------------- (3000).
EARLIEST ACQUISITION/BUILT,YR --- (1980).
MINIMUM ACQUISITION COST, $K ---- (200).

CATEGORY CODE	CATEGORY DESCRIPTION	TYPE CONST	BUILDING / FACILITY NO	ACQUISITION COST ($K)	TOTAL AREA	UNIT MEASURE	YEAR BUILT	NUMBER FLOORS	WALL MATERIAL	TOTAL CAPACITY	UNIT MEASU
72190	OTHER	P	04558	1000	40653	SF	54	4	D	132	MN
72190	OTHER	P	04562	1102	42017	SF	54	4	D	132	MN
72190	OTHER	P	04564	1082	40653	SF	54	4	D	132	MN
72190	OTHER	P	04566	969	40653	SF	54	4	D	132	MN
72190	OTHER	P	04568	1101	40653	SF	54	4	D	132	MN
72190	OTHER	P	04580	1243	42017	SF	54	4	D	132	MN
72190	OTHER	P	04582	933	40653	SF	54	4	D	132	MN
72190	OTHER	P	04584	1204	40653	SF	54	4	D	132	MN
72190	OTHER	P	04586	974	40653	SF	54	4	D	132	MN
72190	OTHER	P	04590	1147	42017	SF	54	4	D	132	MN
72190	OTHER	P	04592	1132	40653	SF	54	4	D	132	MN
72190	OTHER	P	04594	1000	40653	SF	54	4	D	132	MN
72190	OTHER	P	04596	1118	40653	SF	54	4	D	132	MN
72190	OTHER	P	04782	1334	42017	SF	54	4	D	132	MN
72190	OTHER	P	04784	969	40653	SF	54	4	D	132	MN
72190	OTHER	P	04786	1102	40653	SF	54	4	D	132	MN
72190	OTHER	P	04791	332	10195	SF	74	3	D	63	MN
72190	OTHER	P	04792	1243	42017	SF	54	4	D	132	MN
72190	OTHER	P	04793	319	9804	SF	74	3	D	63	MN
72190	OTHER	P	04794	1097	40653	SF	54	4	D	132	MN
72190	OTHER	P	04796	1099	40653	SF	54	4	D	132	MN
72190	OTHER	P	04797	323	9933	SF	74	3	C	55	MN

SCREENED INVENTORY OF MILITARY REAL PROPERTY AT (ORD FORT))

AS OF DATE 063080

CATEGORY CODE FORMAT #3

SCREENING PARAMETERS

MINIMUM AREA, SQ FT ------------- (3000).
EARLIEST ACQUISITION/BUILT,YR --- (1980).
MINIMUM ACQUISITION COST, $K ---- (200).

CATEGORY CODE	CATEGORY DESCRIPTION	TYPE CONST	BUILDING / FACILITY NO	ACQUISITION COST ($K)	TOTAL AREA	UNIT MEASURE	YEAR BUILT	NUMBER FLOORS	WALL MATERIAL	TOTAL CAPACITY	UNIT MEASU
72190	OTHER	P	04798	1097	40653	SF	54	4	D	132	MN
72190	OTHER	P	04799	319	9804	SF	74	3	D	63	MN
72210	ENL PERS MESS	P	03641	1540	13887	SF	78	1	H	845	MN
72210	ENL PERS MESS	P	04453	252	11399	SF	70	1	D	800	MN
72210	ENL PERS MESS	P	04455	252	11399	SF	70	1	D	800	MN
72210	ENL PERS MESS	P	04468	252	11399	SF	70	1	D	800	MN
72210	ENL PERS MESS	P	04470	252	11399	SF	70	1	D	800	MN
72330	ADM - SUP BLDG	P	03640	862	29022	SF	77		C	0	
72330	ADM - SUP BLDG	P	03643	1056	29022	SF	78		C	0	
72330	ADM - SUP BLDG	P	04450	215	12194	SF	70	1	C	0	
72330	ADM - SUP BLDG	P	04458	215	12193	SF	70		C	0	
72330	ADM - SUP BLDG	P	04464	239	12393	SF	70		C	0	
72330	ADM - SUP BLDG	P	04473	215	12194	SF	70		C	0	
72410	BOQ MIL MALE	P	04360	313	14269	SF	53	3	C	14	MN
72410	BOQ MIL MALE	P	04361	304	13843	SF	53	3	C	14	MN
72410	BOQ MIL MALE	P	04362	304	13843	SF	53	3	C	14	MN
72410	BOQ MIL MALE	P	04363	295	22053	SF	56	4	C	30	MN
72410	BOQ MIL MALE	P	04364	261	15936	SF	66	2	C	40	MN
72410	BOQ MIL MALE	P	04366	261	15936	SF	66	2	C	40	MN
73015	CONFINEMENT FAC	P	04953	1125	55487	SF	53	2	C	0	
73030	FIXED LAUNDRY	T	02068	383	49140	SF	41	1	A	0	
74012	BOWLING CENTER	P	03855		20180	SF	66	1	D	0	

SCREENED INVENTORY OF MILITARY REAL PROPERTY AT (ORD FORT 1)

AS OF DATE 063080

CATEGORY CODE FORMAT #2

SCREENING PARAMETERS

MINIMUM AREA, SQ FT ------------- (3000)*
EARLIEST ACQUISITION/BUILT,YR --- (1980)*
MINIMUM ACQUISITION COST, $K ---- (200)*

CATEGORY CODE	CATEGORY DESCRIPTION	TYPE CONST	BUILDING / FACILITY NO	ACQUISITION COST ($K)	TOTAL AREA	UNIT MEASURE	YEAR BUILT	NUMBER FLOORS	WALL MATERIAL	TOTAL CAPACITY	UNIT MEASU
74016	POST CHAPEL	P	04280	675	24670	SF	58	1	D	600	SE
74018	UNIT CHAPEL	P	04483	317	7562	SF	70	1	D	300	SE
74018	UNIT CHAPEL	P	04601	515	7820	SF	77	1	H	300	SF
74018	UNIT CHAPEL	P	04788	226	7898	SF	58	1	D	300	SE
74021	COMMISSARY	P	04240	1082	80590	SF	73	1	D	0	
74034	GYMNASIUM	P	04480	500	20457	SF	70	1	D	0	
74041	LIBRARY MAIN	P	04275		14480	SF	70	1	K	0	
74047	OPEN MESS NCO	P	04260	806	35612	SF	65	1	D	0	
74048	OPEN MESS OFF	P	04368		24152	SF	71	1	D	0	
74050	EXCH BRANCH	P	03642	345	7191	SF	78	1	H	0	
74052	EXCH SVC STA	P	04220		6147	SF	64	1	D	0	
74053	EXCH MAIN RETL	P	04235		72709	SF	70	1	G	0	
74059	PO MAIN	P	04225	226	5216	SF	77	1	D	0	
74068	EM SERVICE CLUB	P	02075	600	51882	SF	43	3	A	0	
74068	EM SERVICE CLUB	P	04600	678	31770	SF	62	1	D	0	
74072	INDR SWIM POOL	P	02237	235	24937	SF	44	1	D	0	
74076	THEAT W/STAGE	P	04230		15908	SF	70	1	R	1000	SE
74077	THEAT W/O STAGE	P	04789	323	14481	SF	58	2	D	1002	SF
83110	SEWAGE TRMT PL	P	02076	2197	3942	SF	65	1	C	164500	KG

CERL DISTRIBUTION

Chief of Engineers
ATTN: Tech Monitor
ATTN: DAEN-ASI-L (2)
ATTN: DAEN-CCP
ATTN: DAEN-CW
ATTN: DAEN-CWE
ATTN: DAEN-CWM-R
ATTN: DAEN-CWO
ATTN: DAEN-CWP
ATTN: DAEN-MP
ATTN: DAEN-MPC
ATTN: DAEN-MPE
ATTN: DAEN-MPO
ATTN: DAEN-MPR-A
ATTN: DAEN-RD
ATTN: DAEN-RDC
ATTN: DAEN-RDM
ATTN: DAEN-RM
ATTN: DAEN-ZC
ATTN: DAEN-ZCE
ATTN: DAEN-ZCI
ATTN: DAEN-ZCM

US Army Engineer Districts
ATTN: Library
Alaska
Al Batin
Albuquerque
Baltimore
Buffalo
Charleston
Chicago
Detroit
Far East
Fort Worth
Galveston
Huntington
Jacksonville
Japan
Kansas City
Little Rock
Los Angeles
Louisville
Memphis
Mobile
Nashville
New Orleans
New York
Norfolk
Omaha
Philadelphia
Pittsburgh
Portland
Riyadh
Rock Island
Sacramento
San Francisco
Savannah
Seattle
St. Louis
St. Paul
Tulsa
Vicksburg
Walla Walla
Wilmington

US Army Engineer Divisions
ATTN: Library
Europe
Huntsville
Lower Mississippi Valley
Middle East
Middle East (Rear)
Missouri River
New England
North Atlantic
North Central
North Pacific
Ohio River
Pacific Ocean
South Atlantic
South Pacific
Southwestern

Waterways Experiment Station
ATTN: Library

Cold Regions Research Engineering Lab
ATTN: Library

US Government Printing Office
Receiving Section/Depository Copies (2)

Defense Technical Information Center
ATTN: DDA (12)

Engineering Societies Library
New York, NY

FESA, ATTN: Library

ETL, ATTN: Library

Engr. Studies Center, ATTN: Library

Inst. for Water Res., ATTN: Library

Army Instl. and Major Activities (CONUS)
DARCOM - Dir., Inst., & Svcs.
ATTN: Facilities Engineer
ARRADCOM
Aberdeen Proving Ground
Army Matls. and Mechanics Res. Ctr.
Corpus Christi Army Depot
Harry Diamond Laboratories
Dugway Proving Ground
Jefferson Proving Ground
Fort Monmouth
Letterkenny Army Depot
Natick Research and Dev. Ctr.
New Cumberland Army Depot
Pueblo Army Depot
Red River Army Depot
Redstone Arsenal
Rock Island Arsenal
Savanna Army Depot
Sharpe Army Depot
Seneca Army Depot
Tobyhanna Army Depot
Tooele Army Depot
Watervliet Arsenal
Yuma Proving Ground
White Sands Missile Range

FORSCOM
FORSCOM Engineer, ATTN: AFEN-FE
ATTN: Facilities Engineers
Fort Buchanan
Fort Bragg
Fort Campbell
Fort Carson
Fort Devens
Fort Drum
Fort Hood
Fort Indiantown Gap
Fort Irwin
Fort Sam Houston
Fort Lewis
Fort McCoy
Fort McPherson
Fort George G. Meade
Fort Ord
Fort Polk
Fort Richardson
Fort Riley
Presidio of San Francisco
Fort Sheridan
Fort Stewart
Fort Wainwright
Vancouver Bks.

TRADOC
HQ, TRADOC, ATTN: ATEN-FE
ATTN: Facilities Engineer
Fort Belvoir
Fort Benning
Fort Bliss
Carlisle Barracks
Fort Chaffee
Fort Dix
Fort Eustis
Fort Gordon
Fort Hamilton
Fort Benjamin Harrison
Fort Jackson
Fort Knox
Fort Leavenworth
Fort Lee
Fort McClellan
Fort Monroe
Fort Rucker
Fort Sill
Fort Leonard Wood

INSCOM - Ch, Instl. Div.
ATTN: Facilities Engineer
Vint Hill Farms Station
Arlington Hall Station

WESTCOM
ATTN: Facilities Engineer
Fort Shafter

MDW
ATTN: Facilities Engineer
Cameron Station
Fort Lesley J. McNair
Fort Myer

HSC
HQ USAHSC, ATTN: HSLO-F
ATTN: Facilities Engineer
Fitzsimons Army Medical Center
Walter Reed Army Medical Center

USACC
ATTN: Facilities Engineer
Fort Huachuca
Fort Ritchie

MTMC
HQ, ATTN: MTMC-SA
ATTN: Facilities Engineer
Oakland Army Base
Bayonne MOT
Sunny Point MOT

US Military Academy
ATTN: Facilities Engineer
ATTN: Dept of Geography &
Computer Science

USAES, Fort Belvoir, VA
ATTN: ATZA-DTE-EM
ATTN: ATZA-DTE-SU
ATTN: Engr. Library

Chief Inst. Div., I&SA, Rock Island,

USA ARRCOM, ATTN: Dir., Instl & Svc
TARCOM, Fac. Div.
TECOM, ATTN: DRSTE-LG-F
TSARCOM, ATTN: STSAS-F
NARAD COM, ATTN: DRDNA-F
AMMRC, ATTN: DRXMR-WE

HQ, XVIII Airborne Corps and
Ft. Bragg
ATTN: AFZA-FE-EE

HQ, 7th Army Training Command
ATTN: AETTG-DEH (5)

HQ USAREUR and 7th Army
ODCS/Engineer
ATTN: AEAEN-EH (4)

V Corps
ATTN: AETVDEH (5)

VII Corps
ATTN: AETSDEH (5)

21st Support Command
ATTN: AEREH (5)

US Army Berlin
ATTN: AEBA-EN (2)

US Army Southern European Task Force
ATTN: AESE-ENG (5)

US Army Installation Support Activity
Europe
ATTN: AEUES-RP

8th USA, Korea
ATTN: EAFE
Cdr, Fac Engr Act (8)
AFE, Yongsan Area
AFE, 2D Inf Div
AFE, Area II Spt Det
AFE, Cp Humphreys
AFE, Pusan
AFE, Taegu

DLA ATTN: DLA-WI

USA Japan (USARJ)
Ch, FE Div, AJEN-FE
Fac Engr (Honshu)
Fac Engr (Okinawa)

ROK/US Combined Forces Command
ATTN: EUSA-HHC-CFC/Engr

416th Engineer Command
ATTN: Facilities Engineering

Norton AFB
ATTN: AFRCE-MX/DEE

EMF Team Distribution

USA ARRADCOM
ATTN: DRDAR-LCA-UK

Director of Facilities Engineering
Miami, FL 34004

USA Liaison Detachment
ATTN: Library
New York, NY 10007

West Point, NY 10996
ATTN: Dept of Mechanics
ATTN: Library

Chief of Engineers
ATTN: DAEN-MPO-B
ATTN: DAEN-MPZ-A
ATTN: DAEN-MPR
ATTN: DAEN-RDL
ATTN: DAEN-MPO-U

National Defense Headquarters
Director General of Construction
Ottawa, Ontario
Canada K1A 0K2

Division of Bldg. Research
National Research Council
Ottawa, Ontario
Canada K1A 0R6

Airports and Const. Services Dir.
Technical Info. Reference Centre
Ottawa, Ontario
Canada K1A 0N8

Aberdeen Proving Ground, MD 21005
ATTN: AMXHE

Ft. Belvoir, VA 22060
ATTN: Learning Resources Center
ATTN: ATSE-TD-TL (2)
ATTN: Kingman Bldg., Library
ATTN: Canadian Liaison Officer (2)

Ft. Leavenworth, KS 66027
ATTN: ATZLCA-SA

US Army Foreign Science & Tech. Center
ATTN: Charlottesville, VA 22901
ATTN: Far East Office

Ft. Monroe, VA 23651
ATTN: ATEN-AD (3)
ATTN: ATEN-FE-BG (2)
ATTN: ATEN-FE-W

Ft. Lee, VA 23801
ATTN: DRXMC-D (2)

Ft. McPherson, GA 30330
ATTN: AFEN-CD

USA-WES
ATTN: C/Structures

6th US Army
ATTN: AFKC-EN

7th US Army
ATTN: AETTM-HRD-EHD

HQ, Combined Field Army (ROK/US)
ATTN: CFAR-EN

US Army Engineer District
- New York
  - ATTN: Chief, Design Br.
- Pittsburgh
  - ATTN: Chief, Engr Div
- Philadelphia
  - ATTN: Chief, NAPEN-D
- Baltimore
  - ATTN: Chief, Engr Div
- Norfolk
  - ATTN: Chief, NAOEN-M
  - ATTN: Chief, NAOEN-D
- Huntington
  - ATTN: Chief, ORHED-D

US Army Engineer District
- Wilmington
  - ATTN: Chief, SAWEN-DS
  - ATTN: Chief, SAWEN-D
- Charleston
  - ATTN: Chief, Engr Div
- Savannah
  - ATTN: Chief, SASAS-L
- Jacksonville
  - ATTN: Const Div
  - ATTN: Design Br., Structures Sec.
- Mobile
  - ATTN: Chief, SAMEN-D
  - ATTN: Chief, SAMEN-C
- Nashville
  - ATTN: Chief, ORNED-D
- Memphis
  - ATTN: Chief, LMMED-DT
  - ATTN: Chief, LMMED-DM
- Vicksburg
  - ATTN: Chief, Engr Div
- Louisville
  - ATTN: Chief, Engr Div
- Detroit
  - ATTN: Chief, NCEED-T
- St. Paul
  - ATTN: Chief, ED-D
- Chicago
  - ATTN: Chief, NCCED-DS
- Rock Island
  - ATTN: Chief, Engr Div
  - ATTN: Chief, NCRED-D
- St. Louis
  - ATTN: Chief, ED-D
- Kansas City
  - ATTN: Chief, Engr Div
- Omaha
  - ATTN: Chief, Engr Div
- New Orleans
  - ATTN: Chief, LMNED-DG
- Little Rock
  - ATTN: Chief, Engr Div
- Tulsa
  - ATTN: Chief, Engr Div
- Fort Worth
  - ATTN: Chief, SWFED-D
- Galveston
  - ATTN: Chief, SWGAS-L
  - ATTN: Chief, SWGED-DS
  - ATTN: Chief, SWGED-DM
- Albuquerque
  - ATTN: Chief, Engr Div
- Los Angeles
  - ATTN: Chief, SPLED-D
- San Francisco
  - ATTN: Chief, Engr Div
- Sacramento
  - ATTN: Chief, SPKED-D
- Far East
  - ATTN: Chief, Engr Div
- Portland
  - ATTN: Chief, DB-6
  - ATTN: Chief, DB-3
- Seattle
  - ATTN: Chief, NPSCO
  - ATTN: Chief, EN-DB-EM
  - ATTN: Chief, EN-DB-ST
  - ATTN: Chief, NPSEN-PL-WC
- Walla Walla
  - ATTN: Chief, Engr Div
- Alaska
  - ATTN: Chief, NPASA-R

US Army Engineer Division
- New England
  - ATTN: Chief, NEDED-T
- Middle East (Rear)
  - ATTN: Chief, MEDED-T
- North Atlantic
  - ATTN: Chief, NADEN-
- South Atlantic
  - ATTN: Chief, SADEN-TS
  - ATTN: Chief, SADEN-TE/TM
- Huntsville
  - ATTN: Chief, HNDED-CS
  - ATTN: Chief, HNDED-ME
  - ATTN: Chief, HNDED-SR
- Ohio River
  - ATTN: Chief, Engr Div

US Army Engineer Division
- North Central
  - ATTN: Chief, Engr Div
- Missouri River
  - ATTN: Chief, MRDED-T
- Southwestern
  - ATTN: Chief, SWDED-TS
  - ATTN: Chief, SWDED-TM
- South Pacific
  - ATTN: Chief, SPDED-TG
- Pacific Ocean
  - ATTN: Chief, Engr Div
  - ATTN: Chief, FM&S Branch
  - ATTN: Chief, PODED-D
- North Pacific
  - ATTN: Chief, Engr Div

AF/PREEU
Bolling AFB, DC 20332

AFESC/PRT
Tyndall AFB, FL 32403

McClellan AFB, CA 95652
2852 APG/DE

Tinker AFB, OK 73145
2854 ABG/DEEE

Patrick AFB, FL 32925
ATTN: XRQ

Little Rock AFB
ATTN: 314/DEEE

Naval Air Systems Command
ATTN: Library
WASH DC 20360

NAVFAC/Code 04
Alexandria, VA 22332

Naval Training Equipment Command
ATTN: Technical Library
Orlando, FL 32813

Port Hueneme, CA 93043
ATTN: Library (Code L08A)
ATTN: Morell Library

Washington, DC
ATTN: Bldg. Research Advisory Board
ATTN: Library of Congress (2)
ATTN: Dept. of Transportation Library
ATTN: Transportation Research Board

AFWL/DES
Kirtland AFB, NM 87117

APO, New York, NY 09055
Chief, Land & Msl. Instl. Section

Washington, DC 20305
Chief, Electronic Vulnerability Div.

Prendergast, James D.
Seismic indexing system for Army installations / by J. D. Prendergast, W. E. Fisher. -- Champaign, IL : Construction Engineering Research Laboratory ; Springfield, VA : available from NTIS, 1981.
2v. (Technical report ; M-290)

Contents: v. 1. Real property inventory screening procedure. -- v. 2. Seismic hazard priority-ranking procedure for Army buildings: basic concept.

1. Earthquakes and building. I. Fisher, Walter E. II. Title. III. Series: U. S. Army Construction Engineering Research Laboratory. Technical report ; M-290.